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## TRANSPORTATION RESEARCH COMMAND
## FORT EUSTIS, VIRGINIA

TREC TECHNICAL REPORT 61-57

# FABRICATION AND FIELD EVALUATION OF A HIGH-CAPACITY, HIGH-EFFICIENCY CHARGE-AIR FILTER SYSTEM FOR ARMY AIRCRAFT

## (Phase I. Design, Fabrication, and Initial Evaluation)

Project 9-89-02-000 ST 137AV

Contract No. DA 44-177-TC-495

June 1961



prepared by :

FRAM CORPORATION
Providence 16, Rhode Island

Mr. L. M. Bartone/bsb/21528

HEADQUARTERS
U. S. ARMY TRANSPORTATION RESEARCH COMMAND
TRANSPORTATION CORPS
Fort Eustis, Virginia

TCREC-ADS 9R38-01-017-45

SUBJECT: Aircraft Carburetor Air Filter Systems

TO: See Distribution List

1. The inclosed Phase I final report is a discussion of the contractor's efforts to design, fabricate, and test a prototype carburetor charge-air filter system. This work was a follow up to a previous program for the development of a high efficiency, high capacity filter media. (Contract DA 44-177-TC-363, Study, Investigation and Preliminary Design of a Universal Dry Type Engine Charge-Air Filter Element).

2. The results of the tests of the prototype system indicate that a high capacity, high efficiency filter system has been achieved.

3. Comparative evaluation tests of the filter designed in this program versus present systems have been made in Phase II of present contract. The results of this evaluation will be reported separately in a subsequent report.

4. Recommendations regarding further specific application development of this filter system will be withheld pending analysis of wear test results comparing the newly designed system with presently used systems. The report of the wear studies will be available by 1 August 1961.

FOR THE COMMANDER:

Earl A. Wirth

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as

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This report presents the design and prototype field evaluation of a new high capacity, high efficiency air filtration system for use on light fixed and rotary wing aircraft. This work was the outgrowth of the original development of an optimum filter medium to protect the air induction system of aircraft from the ingestion of large amounts of dust and other air-borne contaminants.

Preliminary laboratory testing and a field test of the new engine air filtration system were carried out using an Army H-23 helicopter as a test vehicle. The field test program culminated with the certification of the air filter unit by the Federal Aviation Agency (S. T. C. SH1-517 dated 11-16-60). Results of both laboratory and field testing are reported in detail.

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Fram Corporation, Providence, R.I., FABRICATION AND FIELD EVALUATION OF A HIGH CAPACITY, HIGH EFFICIENCY AIR CHARGE FILTER SYSTEM FOR ARMY AIRCRAFT - B. S. McCarroll and J. W. Jackel.

Final Report, May, 1961,
pp-illus-tables
DA Proj 9R38-01-017-45
(Contract No. DA 44-177-TC-495)
(Phase I)

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1. Air Intake Filters
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for
U. S. ARMY TRANSPORTATION RESEARCH COMMAND

FORT EUSTIS, VIRGINIA

# FOREWORD

The Transportation Research Command entered into a contract on 30 June 1958 with the Fram Corporation for the purpose of evaluating and qualifying a new high capacity air filtration system for light aircraft. This contract was a logical sequel to the basic development of the filtration media and preliminary design considerations which took place under Contract No. DA 44-177-TC-363.

The work under this contract was divided into two phases:

> Phase I included the fabrication, evaluation and qualification of an air filtration system for the H-23C helicopter.
>
> Phase II consisted of a field wear study of the H-23C power plant through the utilization of radioactive tracer techniques. The purpose of this work was to evaluate the effect of air and lube oil filtration on the life of critical engine parts, and to evaluate the feasibility of using nucleonic instrumentation for aircraft field tests. A separate final report has been written to present the results of the wear study.

Phase I of this contract was completed 16 November 1960 with the issuance of an F. A. A. Supplemental Type Certificate for the air filtration system. Phase I work required the combined efforts of personnel from the Aircraft Filter and Research Divisions of the Fram Engineering Department in East Providence, Rhode Island. Many people contributed valuable assistance during this evaluation study. Mr. R. Harrison, Design Draftsman of the Aircraft Filter Division, was especially helpful in finalizing the design and in the preparation of the necessary drawings for submission to the Federal Aviation Agency.

Significant contributions in the prototype fabrication were made by Messrs. L. Bessette and R. Lincoln, Sample Shop Supervisor and Toolmaker respectively of the Liquid Filter Division.

Also of great assistance in the flight test program were personnel of the TRECOM Air Section at Fort Eustis, Virginia, under the command of Captain William E. Hart.

The Fram Engineering Department recognizes the importance of effective liaison work between the Contracting Officer and the Contractor during the execution of a study of this type. The work of Branch Head, Mr. L. Bartone, and his assistants, Lts. Donald S. Webster and Thomas B. Allardice, established a propitious atmosphere between the interested parties during this contract.

Fram Project Engineers, B. S. McCarroll and J. W. Jackel, authored this report. The entire development project was carried out under the direction of Mr. W. E. Dowdell, Director, Aircraft Filter Division, Fram Corporation.

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## SUMMARY

This report includes all of the work accomplished in the design, fabrication and field evaluation of a high capacity, high efficiency engine air filtration system.

Using the H-23 helicopter as a test vehicle, an air filter housing was designed and fabricated to house the dual media filter element developed under Contract No. DA 44-177-TC-363. The filter includes a pressure drop warning system and a bypass circuit to preclude any possibility of excessive induction system pressure drop occurring due to extreme contamination at the barrier filter.

An extensive field test program led to the optimization of the design and certification of the filtration system by the Federal Aviation Agency.

## INTRODUCTION

The fundamental accomplishments realized during the study and investigation of dry filtration media under Contract No. DA 44-177-TC-363 made available a high capacity filter element for use on light aircraft. The application of this basic knowledge to the design of a compatible system for a particular aircraft required a full engineering evaluation substantiated by laboratory and field tests.

Preliminary designs of air charge induction filter systems for most Army aircraft were available for finalization and subsequent study. The Transportation Corps made available to the Contractor an H-23C aircraft for use in the evaluation of the air filter element and envelope.

The steps leading to qualification of the H-23C air filter system are outlined as follows:

1. Finalization of Design and Prototype Manufacture

   a. Modification to the filter element components to insure economical manufacture, to facilitate maintenance, and to maintain optimum performance.

   b. Design of a filter housing to provide optimum air flow characteristics without compromising on engine performance.

   c. Design of a sensitive pressure drop warning system to provide visual indication of excessive filter element pressure drop.

   d. Incorporation of a quick opening backfire door to protect the filter element and to provide an alternate air supply entrance downstream of the filter.

2. Preliminary Tests

   a. A test to simulate carburetor flooding and to prove the capabilities of the fuel drainage provisions in the new design system.

   b. Test stand operation of the pressure drop warning system to insure validity.

   c. Laboratory test to check the operation of the backfire door mechanism under reverse pressure.

   d. Operation of the system with humidity and temperature levels of the incoming air charge adjusted to promote cartridge icing. This test was devised to ascertain the effects of ice formation on air flow as indicated by abnormal restriction build-up.

3. System Flight Safety Check

   a. The complete air induction filter system to be mounted on the H-23C and the aircraft flight tested for a sufficient period of time to prove the reliability of the new installation and establish the operation characteristics.

   b. Establish the effect (if any) which the new air filter system reflects on over-all engine performance.

   c. An indication of final qualification from the Federal Aviation Agency in the form of a Supplemental Type Certificate.

## DESIGN AND PROTOTYPE FABRICATION

The transition from the preliminary air filter design to the final system design as shown in Figure 1 occurred as a series of logical modifications during the laboratory and flight test programs. The basic evolution of the system will be traced in this section while much of the detail description and substantiating reasons for the design changes will be discussed in the section on flight testing.

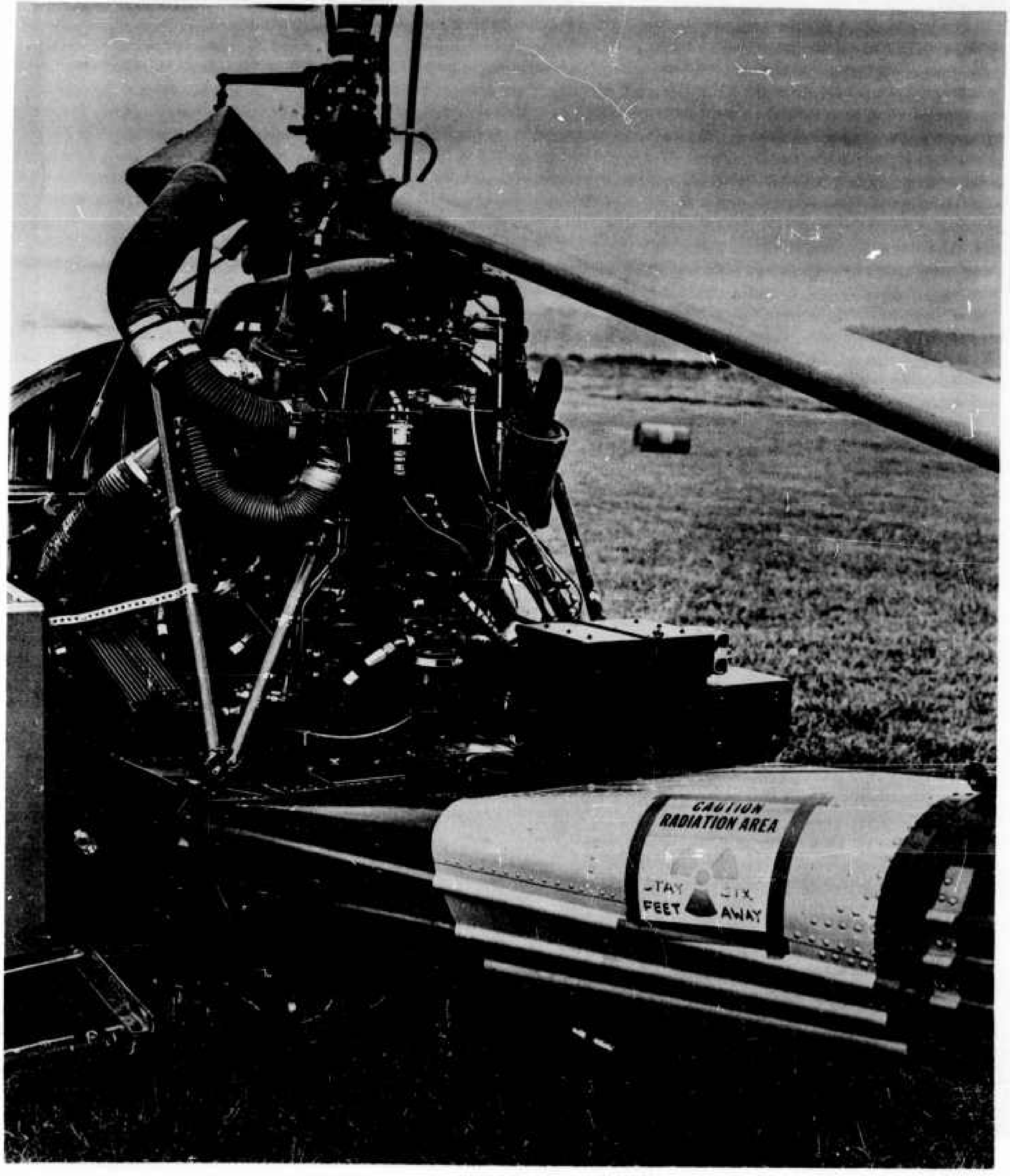



Figure 1. High Capacity-High Efficiency Air Filter for H-23C Helicopter

Substitution of the new design air filter in place of the existing mixing box unit (Figure 2) without major alterations to the air intake system was a definite consideration in the finalization of the design. A filter housing as shown in Figure 3 was designed to be installed just below the carburetor and physically about in the same position formerly occupied by the air mixing box. The hot air duct from the muffler was made an integral part of the housing. The basic envelope for the "A" size filter element (Figure 4) was retained from the preliminary design and a dual purpose bypass and backfire door was incorporated into the cartridge entrance cover.

The initial stages of the flight test program pointed out a definite weakness in this design. The introduction of the hot air supply through a door hinged in a vertical line tended to direct the hot air stream toward one side of the filter cartridge and resulted in a media collapse problem. This factor dictated a change in design whereby the hot air duct was divorced from the filter housing. The warm air intake in the filter housing was moved somewhat upstream from its original position and relocated on the bottom of the housing. The connection between the muffler and filter housing was made flexible. The repositioning of this intake allowed the addition of an internal air deflector and the pivoting of the mixture door in a horizontal line. This resulted in a more favorable blending of the hot and cold air supplies.

A by-product of this design change is a housing which is more economical to produce and easier to install as a substitute for the mixing box. The elimination of the hot air duct as an integral part of the filter reduced the required welding on the housing considerably. The flexibility between the muffler and the filter will facilitate field installation and remove the need for costly close tolerance dimensioning of the housing.

Further design changes occurred as a direct result of comparative engine tests under full power conditions. Caburetor air temperatures higher than those recorded with the original mixing box design pointed out the need for reducing the transfer of heat from the engine to the incoming air stream.

The first approach to solving the "high temperature" problem was to reorient the filter housing to a position away from the engine and into an area of lower temperature. This relocation of the housing did lower the carburetor air temperatures to an acceptable level. However, subsequent evaluation of the system pointed out the need for further study of the "high temperature" problem.

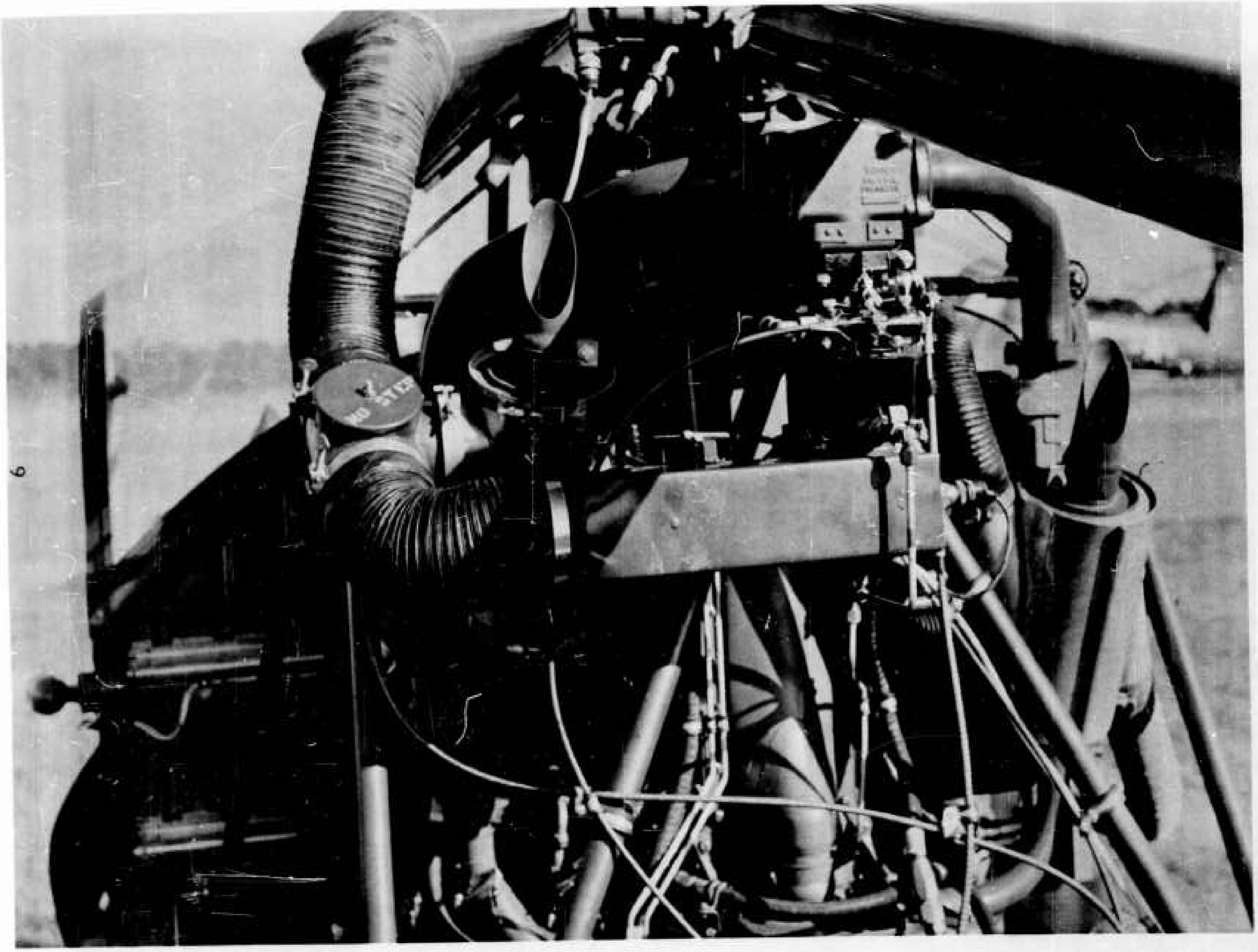


Figure 2. Original H-23C Engine Air Induction System

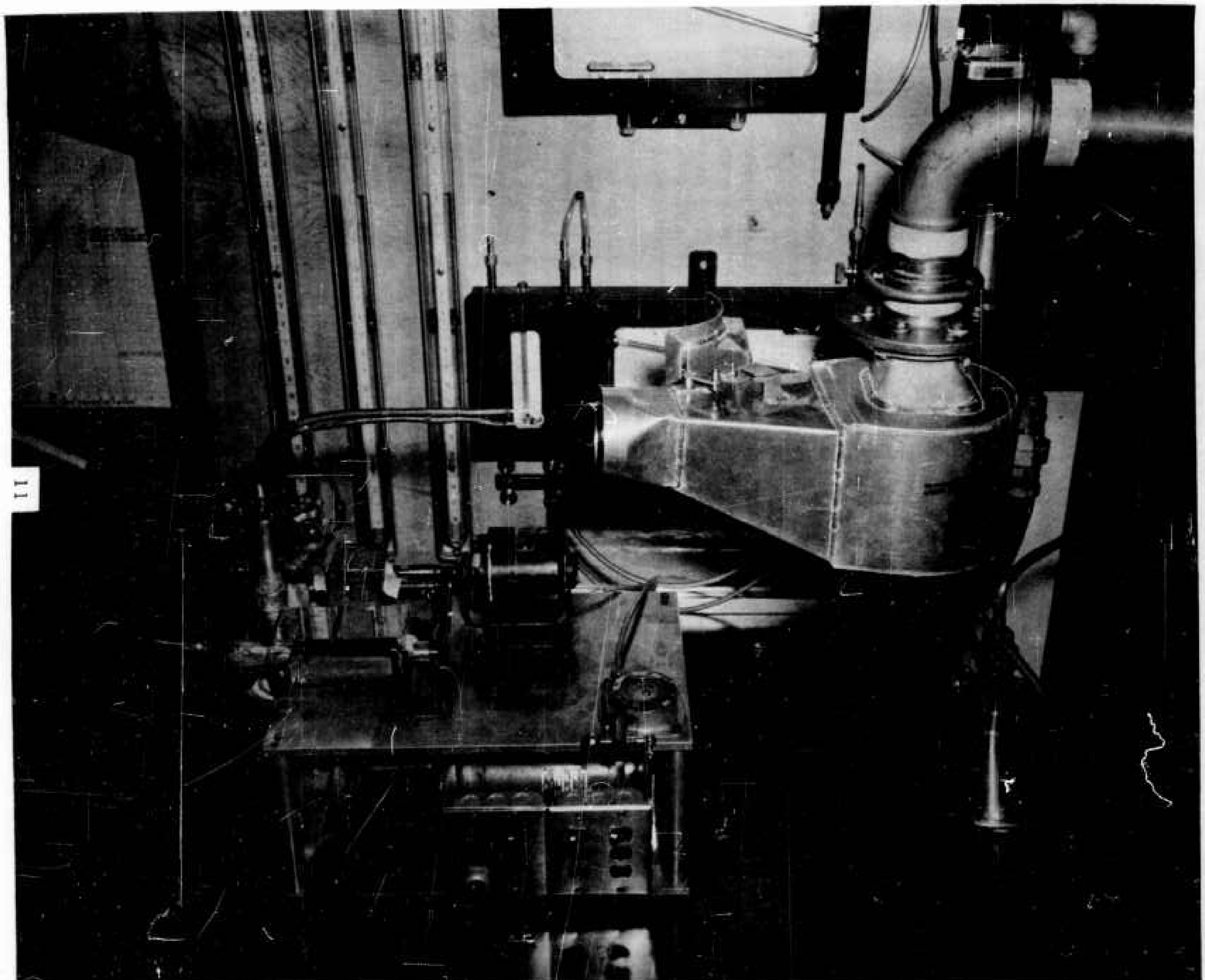


Figure 3. Filter Housing

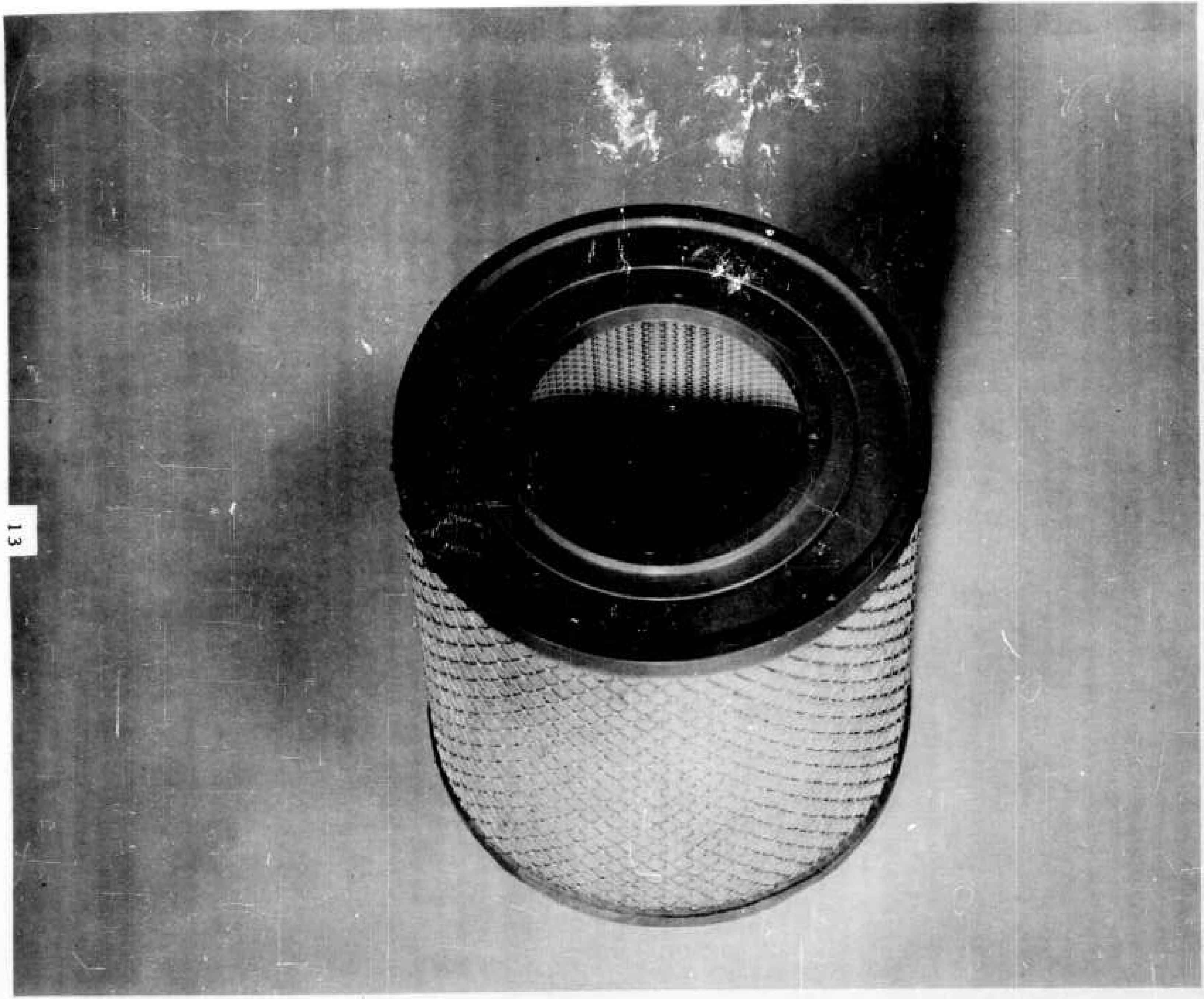


Figure 4. High Capacity-High Efficiency Air Filter Element

The minimum acceptable carburetor air "heat-rise" (for the particular engine being used) should not exceed 90°F. At the new location of the filter, this minimum heat rise could not be obtained because of the excessive dissipation of heat from the muffler over the relatively long air induction path. A search was made for an optimum filter location where carburetor air temperature for both normal and "full heat" usage was acceptable. It was determined in field testing that the only feasible filter location, which would provide the proper carburetor deicing heat, was the original location directly below the carburetor.

Now that the position of the air filter was finalized, a method had to be found whereby the aluminum filter body could be insulated from the engine heat sources. It was determined that there were two sources of heat affecting the filter installation. The first source was muffler heat which was conducted via the hot air ducting to the filter body. The installation of a butterfly valve to the muffler hot air exit and the asbestos insulation of the filter hot air door limited this heat transfer to an acceptable level.

Insulation of the filter housing from the second heat source, radiation heat from the engine, proved a more formidable problem. This heat source produced temperatures of as high as 200°F. at the forward face of the housing. Shielding the filter body from the engine was tried, but proved unsatisfactory because of the space limitations. Various insulating materials to be applied to the filter body were investigated. After laboratory testing of insulation materials, a polyvinyl chloride coating was selected as a suitable, long life insulating material which could be applied at a reasonable cost. This protection was applied to the vertical sides of the filter to a thickness of .050 inches through a dipping process. Subsequent field tests proved the suitability of the plastic coating as reflected by the flight data in Appendix I.

The new air filter system is approximately 3.5 pounds heavier than the original mixing box system. The filter housing, a clean cartridge, adapter and pressure-drop switch weigh 6.5 pounds while the weight of the mixing box and flocked screen filter is approximately 3 pounds. In other words, a high capacity-high efficiency air filter has been added to protect the engine at a "cost" of 3.5 pounds.

A reliable and simple warning system to give a visual indication of the end of the useful life of the filter element was considered a desirable supplement to the new filter system. Military Specification F-7194 was used as a guide during all of the design considerations and Paragraph 4.3.3.1.1.2 was adhered to in determining the maximum pressure drop (8 inches of water) to be tolerated across the filter element.

The ground test data for the original filter installation (see Figure 5) indicated that a pressure drop of about 1.5 inches exists in the H-23C system from the inlet scoop to the entrance to the carburetor. Therefore, a pressure drop of 9.5 inches of water between the air intake and the carburetor was established as a maximum restriction.

A suitable pressure switch for detecting pressure differential in the "zero to ten inches of water" range was procured. This metal diaphragm type switch with normally open contacts is designed for use in a 28 volt circuit and will tolerate up to a maximum of 5 amperes current. It is designed for aircraft application and has an AN approved snap action switch element.

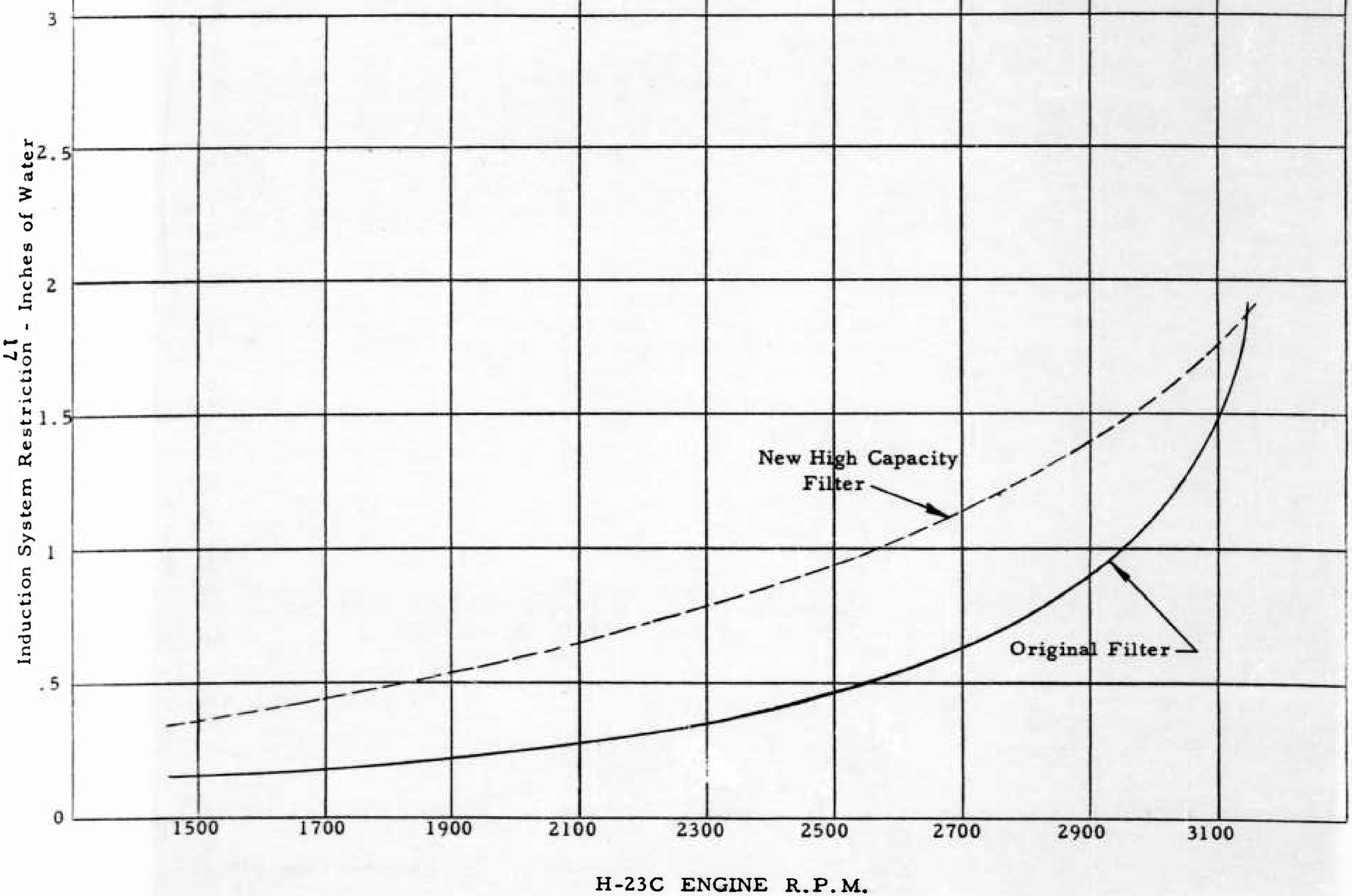
The switch is mounted on the adapter directly beneath the carburetor and is connected to the aircraft's electrical circuit as shown in AX-26074, (Figure 6). The circuit is protected by a 5 ampere breaker mounted on the auxiliary cockpit panel.

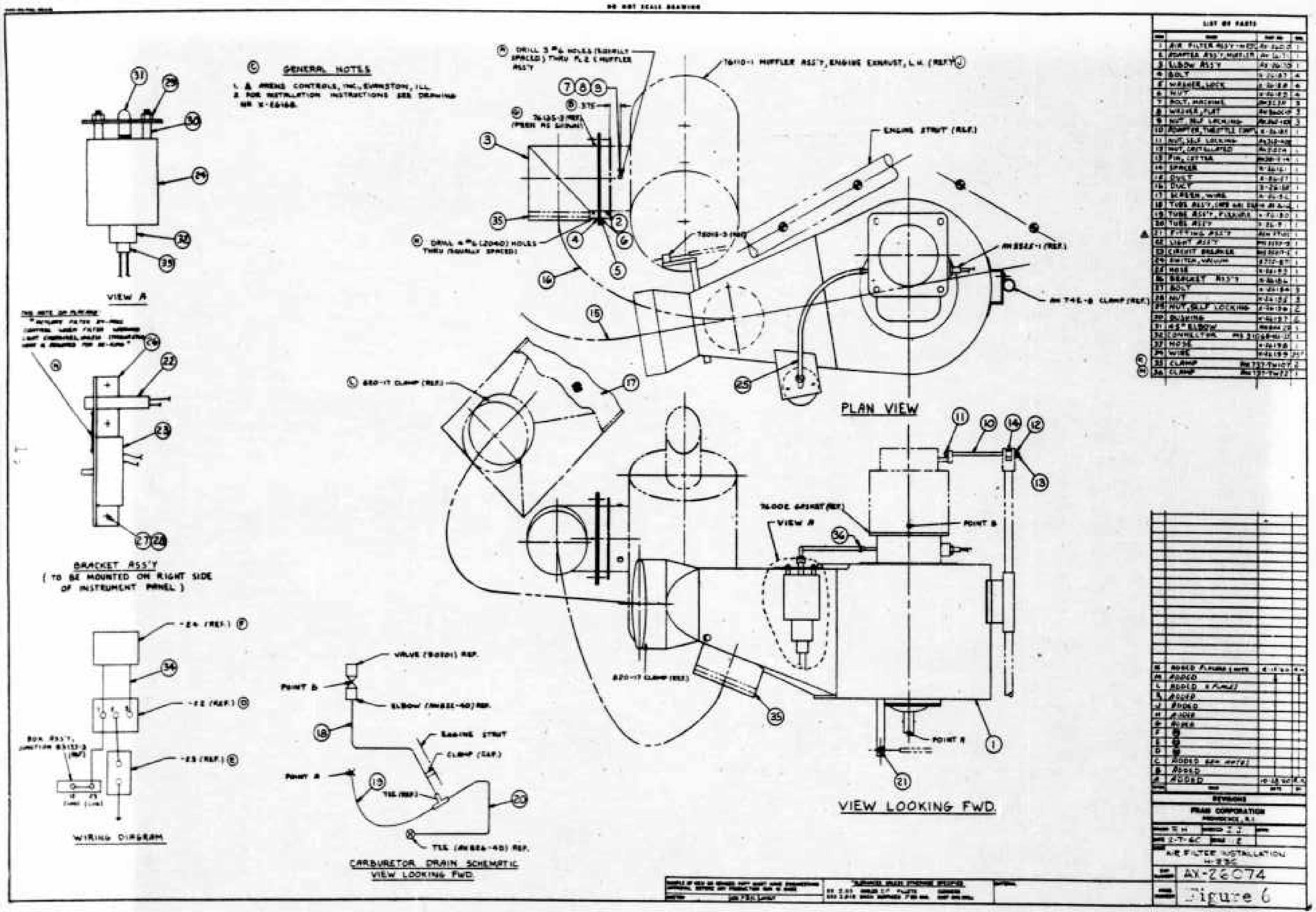
The warning system produces a visual signal in the cockpit when a pressure drop of 9.5 inches (± 0.5 in.) of water exists between the air intake scoop and the carburetor. A flexible cable attached to the bypass door and terminating in the cockpit permits the pilot to introduce an alternate unfiltered air supply.

The physical sizes of the family of three high capacity filter cartridges were determined under the basic research contract. However, optimumization of the media pattern for the "A" size cartridge was accomplished under this contract. Changes to the media configuration and the design characteristics of the cartridge will be discussed here, while modification to the media specifications which were a direct result of the flight test program will be discussed as part of that work.

Considerable testing of the filter element was carried out on an air media test stand, Figure 7, at air flows up to 300 CFM while using heavy concentrations of aspirated A. C. Dust (9 grams per minute) to determine the optimum pleat configuration. The use of an inner ring of 70 one inch pleats of filter paper within an outer layer of 3/4 inch batt material has consistently resulted in excellent capacity and efficiency characteristics.

FIGURE 5
Clean Pressure Drop vs. Engine R.P.M.
H-23C Helicopter
Ground Check - North Central Airport





DO NOT SCALE DRAWING
GENERAL NOTES
LIST OF PARTS
PLAN VIEW
VIEW LOOKING FWD.
VIEW A
BRACKET ASS'Y
( TO BE MOUNTED ON RIGHT SIDE OF INSTRUMENT PANEL )
WIRING DIAGRAM
CARBURETOR DRAIN SCHEMATIC
VIEW LOOKING FWD.
ENGINE STRUT (REF.)
POINT A
POINT B
REVISIONS
AIR FILTER INSTALLATION H-23C
AX-26074
Figure 6

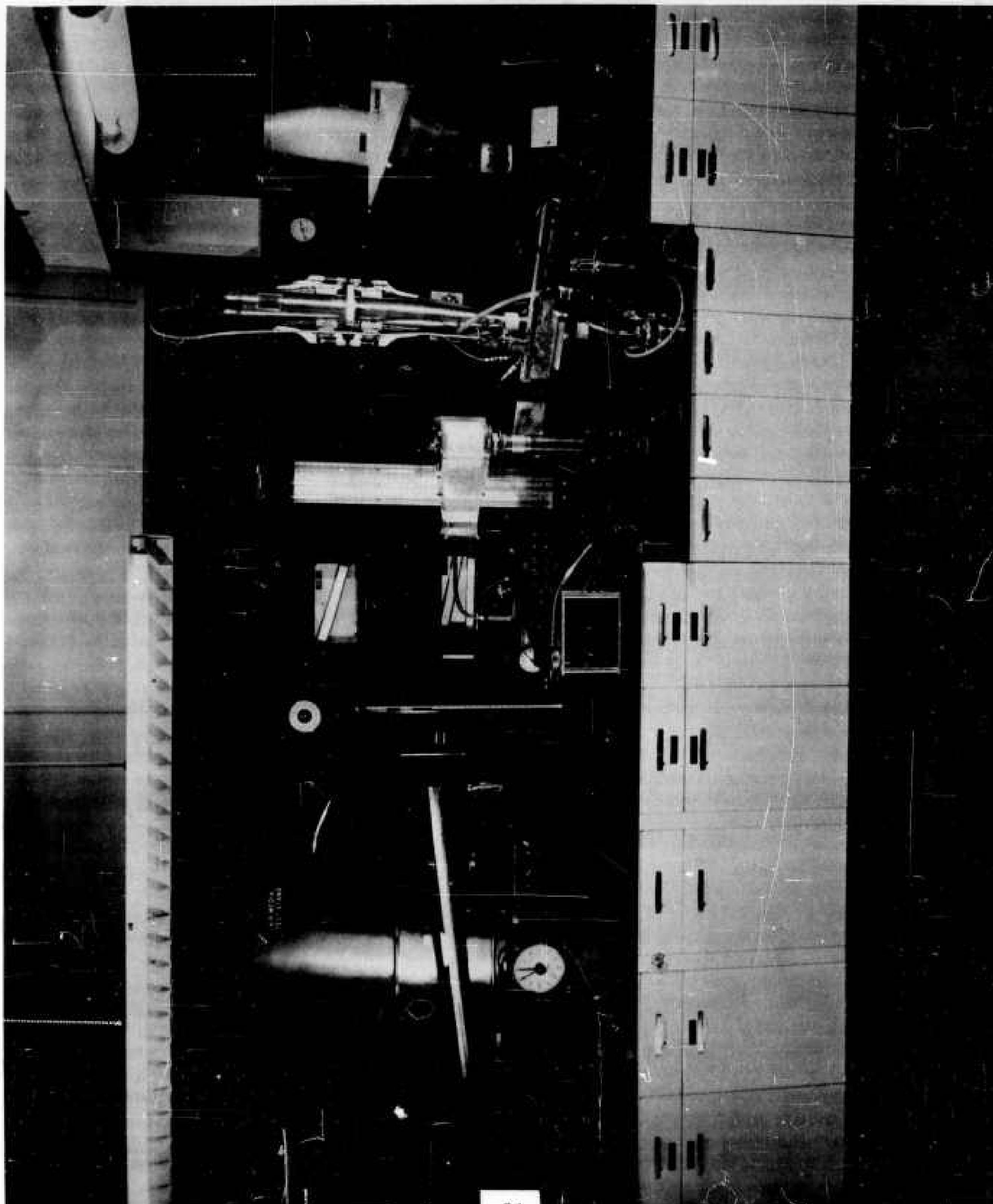


Figure 7. Air Media Test Stand

The final design of the filter element has included a change from an aluminum end cap with attached gasket to a molded end cap which also serves as a seal between the element and housing. The metal end was used in conjunction with a cellular sponge synthetic rubber gasket which had to be cut and correctly bonded to the end cap. The bonding process consisted of a cycle which included the application of a pre-coat before the adhesive was introduced and would have resulted in a costly production procedure. Any deviation from the correct bonding technique could have resulted in loose gaskets and a faulty filter system.

Therefore, to lower production costs and to come up with a better designed cartridge, the use of a molded end (vinyl copolymer) has been introduced in place of the aluminum end cap. The orientation of the outer screening has been shifted to provide a tight lock between the plastic and the metal screen at the element ends. Figure 4 shows the final cartridge design.

Fundamentally, the over-all design of the filter housing was not changed, since the flow characteristics provided by the preliminary design (Contract No. DA 44-177-TC-363 Phase II) were good.

## PRELIMINARY GROUND TESTING

A laboratory test program to check the reliability of the H-23C filter system before integrating the unit into the aircraft for flight testing was considered essential. Therefore, one of the aluminum prototypes was mounted on the air media test stand with all of the associated controls appended and thoroughly checked for safe operation under normal and unusual climatic conditions.

Adequate provision for the possibility of excessive fuel drainage from the up-draft carburetor as a result of unusual conditions was considered in the design of the housing backfire door. Gasoline from the carburetor can flow down into the concave profile of the door and be relieved through a check valve in the line. This ball check valve opens when the air flow through the system is below approximately 125 cubic feet per minute. The six cylinder air cooled engine in the H-23C requires air at a rate of 300 cubic feet per minute for full power at 3100 revolutions per minute engine speed. Allowing for ground operations at engine speeds down to 2000 revolutions per minute and reduced volumetric efficiencies, this valve will be closed whenever the engine is breathing.



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Proper operation of the pressure drop warning system was included as part of the bench testing program. The pressure switch, which measures the differential between atmospheric pressure and induction system pressure downstream of the filter cartridge, has good repeatability. It was checked in excess of 50 times on the test stand with fully loaded cartridges in the system and reliably indicated the need for bypass operation. The switch closes at 9.5 inches ($\pm$ 0.5 inches) of water (vacuum). Closing activates the control panel warning light. The differential travel of the switch between open and close was kept to a minimum so that if operational circumstances permit a reduction of air speed, the resulting decrease in pressure drop at lower flow rates will remove the warning signal and indicate the continued use of the filter. The major warning system components including the switch signal light and circuit breaker are AN items.

The ability of the new system to withstand a backfire through the intake manifold was a major consideration of the preliminary testing program. The medium adjacent to the center support screen in the filter element is a flameproof paper which definitely does not support combustion. The 16 x 16 mesh screen also inhibits the spread of flames.

A severe backfire test was carried out on an engine dynamometer test stand. The filter housing with an element in position was mounted on the down draft carburetor of a six cylinder automotive engine which in turn was coupled to a fluid torque load. The engine timing was disoriented so that reverse fires were created with flames extending back through the filter element center tube. One element was subjected to fifty backfires of varying intensity without any evidence of continued combustion. The spring loaded backfire door adequately relieved the pressure build-up. The element, which withstood the backfire test, was transferred to the air media test stand and its performance characteristics were found to be equal to a typical "A" size element.

The formation of ice on the filter element was investigated in the laboratory from the standpoint: "What will happen to engine performance when atmospheric conditions promoted the growth of crystals of ice on the fine fibers of the batt material in the new element?" This problem was studied on the air media test stand and the static pressure drop through the element was scrutinized for evidence of excessive restriction build-up.

The ice study had to be performed with a one-half size cartridge to permit the use of refrigeration equipment (Figure 8) of reasonable capacity. The air flow through the element was reduced to 150 cubic feet per minute so that face velocity of the air was equivalent to the maximum value.

Finely divided particles of water from two nozzles were introduced into the cold moving air stream about eighteen inches upstream of the element. Adjustments in air temperature and relative humidity were made until favorable conditions for icing at the element existed. As ice formed through the batt medium, coarse A. C. Dust was aspirated intermittently at a rate of nine grams per minute. The test was terminated when the restriction through the system reached ten inches of water.

Two icing tests (Tables 40 and 41) are included as part of this report. The static pressure build-up, although more rapid than under temperate conditions was definitely not alarming. The test indicated that if ice formed through the medium, the filter could be left in the system and normal air charge heating procedures followed until thawing relieved the condition.

## SYSTEM FLIGHT SAFETY CHECK

A general flight safety check program was scheduled to qualify the new dry type air filter for optional usage on the test vehicle. The aim of this phase of the evaluation study was to prove the reliability of the new filter system in flight and to determine the extent of any changes in engine performance due to the substitution of the batt-paper filter (e.g. power loss).

Initial flight testing was carried out over local areas approved by the F. A. A. One of these areas adjacent to the North Central State Airport in Smithfield, Rhode Island contained terrain with loose topsoil and gravel which provided severe dust concentrations when stirred up by a hovering helicopter.

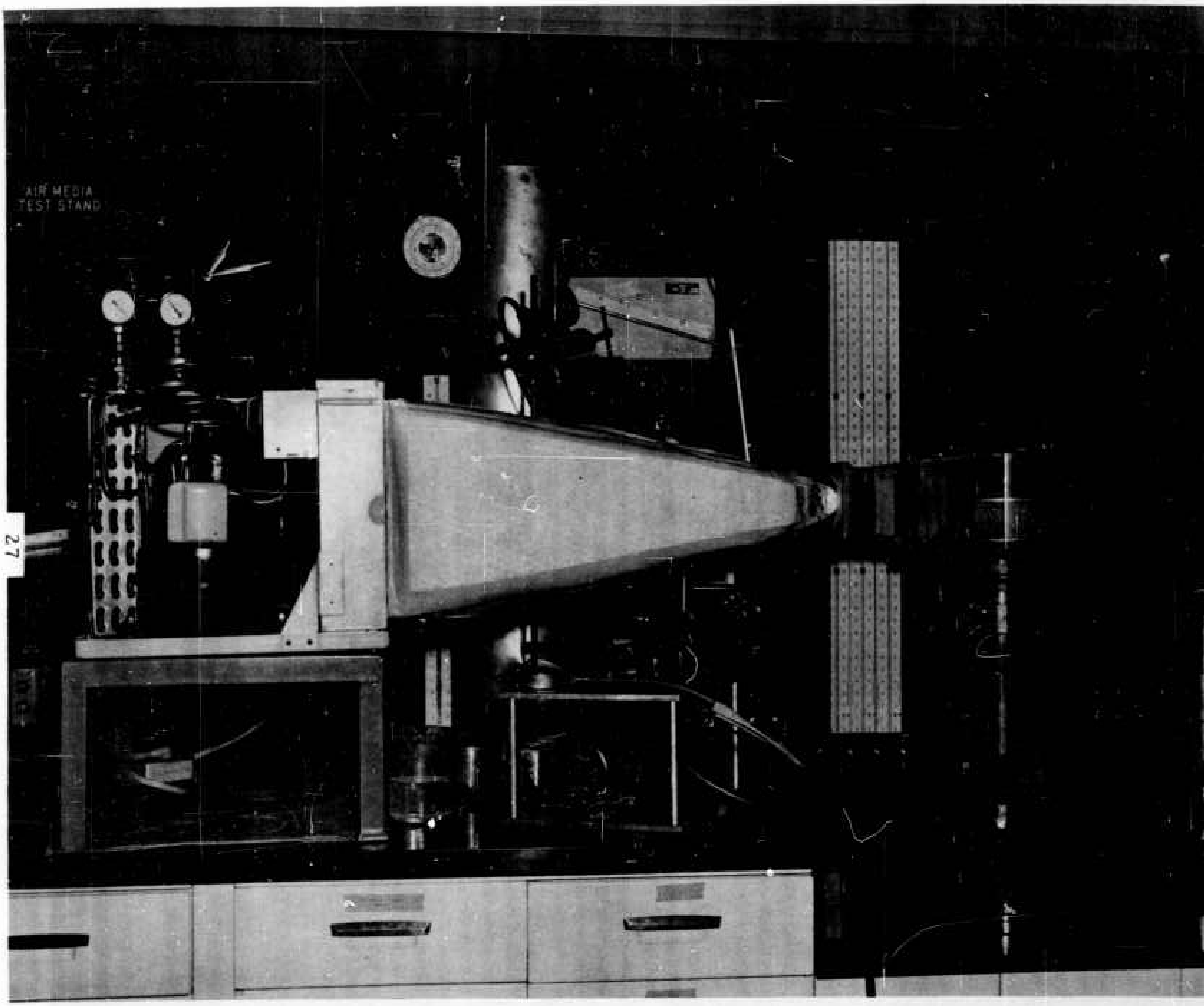


Figure 8. Laboratory Icing Test

Various engine parameters were established with the standard flock-screen type air filter in the system and a typical ground check at various engine speeds is shown in Figure 7. A static pressure drop of about 1.5 inches of water at 3100 revolutions per minute was measured by manometer with manifold pressure running about 15 to 16 inches of mercury. Very slight increases in the static pressure were in evidence after substitution of the new high capacity cartridge with housing. No significant changes in manifold pressure were detected.

A flight test to establish the reliability of the pressure drop warning system was performed. A filter element contaminated with about 300 grams of A. C. Coarse Dust was inserted in the system and the helicopter operated at full power in a three to four foot hover. The warning light gave immediate notice of the maximum permissible restriction. The helicopter was kept in a hover for approximately thirty minutes while the bypass control was intermittently operated to insure the reliability of the pressure switch and associated system. No fault was found with the warning device or the bypass control. However, this test was brought to an abrupt termination when the engine suffered a serious loss of power. The power loss was traced to spark plug fouling. A laboratory analysis of the deposits on the plugs revealed an eight percent silica content and suggested the possibility of dust migration from the artificially loaded element.

Further laboratory tests were immediately instigated to ascertain if the vibrations experienced during flight tended to loosen fine dust from the batt media and promote its passage through the filter paper. A definite migration of particles in the ten to thirty micron range was established by these tests on the air media test stand.

This was the first time that a contaminant migration problem had arisen. The possibility of such an occurrence had been investigated under the media research on the previous contract and at that time, simulated flight vibrations did not cause migration. The search for a new filter paper which would overcome fine contaminant migration was started and two papers of about the same porosity and pore number were investigated.

The use of a lower porosity paper had to be offset by introducing a new technique in the pleating process so that the clean element pressure drop did not significantly increase. A new process which puts corrugations in the paper medium contributes substantially to the overall performance of a filter element of this type. The technique allowed the use of a lower porosity paper with no sacrifice in clean restriction. The final configuration of the paper is inherently easier to assemble in the envelope. The corrugations allow the paper to breathe properly and contribute greatly to increased capacity since useful filter medium area is increased. Also, overall filter element efficiency of better than 98 percent has been consistently maintained during the laboratory test program.

Simulated vibration tests as a check on migration with the new filter paper revealed a reduction of approximately 15 to 1 in the particle migration. Therefore, we feel that the new lower porosity paper has overcome the dirt retention problem with no increase in cost and has resulted in an element with better performance characteristics.

Another media problem turned up during the flight test program. It was noticed that the batt material in one particular area on the element periphery took a permanent set after extremely short periods of engine operation. The location of this batt collapse phenomena was on the side of the element facing the inlet duct and slightly to the left of the flow divider on the engine side of the housing.

At first this deformation problem was thought to be attributable to the high velocity air stream. However, the inclusion of a solid flow divider had no visible effect on the tendency of the batt fibers to crush together.

Since the melting temperature of the air laid batt material was known to be in the range of $165^{\circ}$ to $200^{\circ}$F., the possibility of high temperature air changing the characteristics of the batt medium was next considered. An iron constantan thermocouple capable of reasonable accuracy over the temperature range expected was used to record batt temperatures around the periphery of the filter element during flight tests.

Batt temperatures were recorded for various settings of the carburetor heat control over the range from no heat added to full carburetor heat with indicated temperatures of better than $122^{\circ}$F. at the carburetor. The results of this investigation were as follows:

1. With no introduction of hot air, the batt did not deform.

2. Temperatures as high as $240^{\circ}$ to $250^{\circ}$F. were recorded in the batt to support carburetor air temperatures in the range of $89^{\circ}$ to $130^{\circ}$F.

3. Temperature of the batt varied considerably around the periphery of the cartridge. A temperature differential of approximately $100^{\circ}$F. existed between the area of the cartridge showing collapse and the side of the cartridge furthest from the incoming air charge.

4. A change in $30^{\circ}$ to $40^{\circ}$ F. in batt temperatures was encountered depending on whether the aircraft was oriented with the engine into the wind or not. This showed that radiation effects from the engine were contributing to high localized temperature levels in the element.

A. C. Dust tests using cartridges with deformed batt media proved that actually the collapse did not lead to a significant loss of capacity or efficiency. This can probably be attributed to the fact that the pre-cleaner compression actually took place over a small area and that at moderate face velocities, the density of the batt is not too critical. However, an investigation was deemed necessary to overcome this problem.

Two approaches were taken to circumvent the difficulties introduced by the high temperature air stream. First, the supplier of the batt material was asked to change the batt blend so that higher temperatures could be tolerated at no risk of a change in state. Secondly, a redesign of the filter housing was undertaken in an attempt to promote better mixing of the hot and cold air streams.

As previously described in the section on Design & Prototype Fabrication, the elimination of the hot air duct as an integral part of the filter and the movement of the hot air door to a position slightly upstream from its original location resulted in a more homogeneous mixing of the air supplies. Batt temperatures recorded after the redesign showed that even at "maximum heat", the media temperature did not go above $155^{\circ}$F.

A new batt blend which will remain stable at temperatures up to $300^{\circ}$ F. is now available. This new medium has undergone considerable A. C. Dust testing and has capacity and efficiency characteristics equivalent to the present batt. Since the temperature problem has been avoided by a better housing design, it is planned to specify the original batt. The new high temperature medium is good protection against a similar problem on another aircraft which might not lend itself to a change in filter design.

One of the most important of the design criteria for the new air filter installation was the maintenance of carburetor air temperature, cylinder temperatures, and oil temperature, within the ranges specified by the engine manufacturer.

In the field testing of the original mixing box installation (Tables 4 and 5) minimum carburetor air heat rise at 75% rated B.H.P. and 30°F. outside air temperature was in excess of 90°F. The carburetor cooling data (Tables 10, 16, 22, 28, and 34) showed a maximum C.A.T. rise of 17°F. above ambient temperature under maximum power, no wind conditions. The F.A.A. criteria was a minimum heat rise of 90°F. at 75% rated B.H.P. and a maximum of 14°-17°F. carburetor air temperature above ambient temperature for any power requirement.

Cylinder temperatures and oil inlet temperatures on the original installation, the new installation unrestricted, and the new installation restricted were within their maximum permissible operating temperatures as shown in Tables 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37 and 39.

The cylinder and carburetor air temperature data was monitored with iron constantan thermocouples and a bridge circuit pyrometer potentiometer. A thermocouple probe was inserted into the carburetor throat inlet in place of the aircraft's temperature probe and associated gauge. Cylinders were monitored at the head through the use of a tabbed spark plug gasket to which the thermocouple was welded.

The F.A.A. flight test program for qualification of the new induction system for a Supplemental Type Certificate was conducted in three phases for direct comparison of the original air filter installation, the new air filter installation, and the new installation restricted to 10 inches of water pressure differential. An outline of this program follows:

I. Test to determine hottest cylinder.

II. Full power hover tests at maximum gross weights.

III. Full power hover tests at 100 pounds less than maximum gross weight.

IV. Full power hover tests at 200 pounds less than maximum gross weight.

V. Full throttle climb tests at gross weight.

VI. Carburetor air heat tests.

The first full power tests brought out the fact that the new filter installation design when located directly below the carburetor, raised the average level of carburetor air temperature approximately 25°F. The average carburetor air temperature with the new filter in the system was about 135°F. for an outside air temperature of about 77°F. Carburetor air temperatures with the original mixing box design averaged about 110°F. with the same outside air temperature. An increase in carburetor air temperature of about 10°F. could result in approximately a one percent loss in power output. Therefore, this differential could have contributed to a 2 to 3 percent power loss. A lowering of performance was looked upon as an undesirable by-product of a design change and steps were immediately instigated to bring engine performance characteristics back in line.

Apparently, the insertion of the high efficiency-high capacity filter element in the air induction system had permitted ambient air temperature effects to have considerable influence on the air charge just before the charge entered the carburetor. The ambient air temperature in the area below the carburetor at the forward wall of the new filter averaged 160-180°F. due to the close proximity of the engine. The diffusing action upstream of the filter element allowed a greater transfer of heat from the surrounding atmosphere than could occur under the higher stream velocities existing through the original mixing box.

The element was removed from the housing and carburetor air temperatures checked with the air passing through the empty housing. Under these conditions there was no build-up in carburetor air temperature and it was concluded that the temperature rise could be attributed to ambient effects on the low velocity air charge.

A change in the location of the filter housing seemed to be a reasonable approach to elimination of the high temperature problem. As a first step, the housing was moved away from the engine by the introduction of a 45° elbow adapter between the carburetor and the filter. A metal shield was also placed forward of the filter to intercept and deflect the hot air being blown back by the cooling fan. Carburetor air temperatures measured using this design configuration were very slightly lower than with the housing directly below the carburetor.

The next step involved the more radical movement of the filter housing to a position entirely away from the carburetor and out of the area between the two mufflers. Full power tests at maximum gross weight now showed that carburetor air temperatures were approximately the same for the new filter system as they had been with the original air filter system. Moving the housing into a location in which cool air could circulate around the unit eliminated the increase in the temperature of the incoming air charge. However, as was previously mentioned, this relocation lengthened the path the hot air charge travelled to the extent that carburetor air temperature rose by only 60°F. at full heat conditions. This was corrected by the application of the insulated housing design located directly beneath the carburetor. Tables 7 and 9 graphically display the final design deicing characteristics of the system.

In summary of the field data obtained and notated in the accompanying tables, we can state that no significant difference can be detected between the performance characteristics of the H-23C engine being supplied air through a high capacity filter system, and one breathing through the original flocked screen type air cleaner system.

For test purposes, a high capacity cartridge was artificially restricted to 10 inches of water. A loss of manifold pressure of 0.5 inches of mercury existed when this cartridge was placed in the system. A manifold pressure drop of similar magnitude should be expected with a cartridge contaminated to a level which causes the by-pass warning light to be activated.

The field data of the report tables was submitted to the F. A. A. to support a request for a Supplemental Type Certificate to cover the installation of this dry type high capacity-high efficiency air filter installation on the H-23C helicopter. After a confirming field check by F. A. A. personnel of their Flight Test and Propulsion Section, an F. A. A. Supplemental Type Certificate authorizing this installation on H-23C aircraft was issued 16 November 1960.

The final installation design of the system is included as Figure 8 of this report.

# APPENDIX I

## FLIGHT TEST DATA

TABLE I

Original Mixing
Box Installation

## TEST TO DETERMINE HIGHEST CYLINDER HEAD TEMPERATURE

DATE 5 July 1960 WIND VELOCITY 3-5 KTS

OUTSIDE AIR TEMPERATURE 84°F. BAR. PRESSURE 29.98

REL. HUMIDITY 82%

DESCRIPTION: Hover at gross weight (2500 lbs.) and maximum power at 50 ft. P.A.

| Time (Minutes) | MP In. Hg. | RPM | CYLINDER HEAD TEMPERATURE °F | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | #1 | #2 | #3 | #4 | #5 | #6 |
| 0 | 27 | 3100 | 295 | 240 | 310 | 275 | 275 | 265 |
| 2 | | | 350 | 300 | 317 | 355 | 330 | 315 |
| 5 | | | 420 | 305 | 360 | 357 | 385 | 345 |
| 7 | | | 438 | 340 | 358 | 355 | 398 | 347 |
| 9 | | | 445 | 331 | 365 | 352 | 400 | 352 |
| 11 | | | 445 | 342 | 370 | 357 | 408 | 356 |
| 13 | | | 449 | 347 | 366 | 360 | 405 | 355 |
| 15 | | | 447 | 343 | 367 | 360 | 409 | 351 |
| 17 | | | 444 | 342 | 369 | 354 | 404 | 352 |
| 19 | | | 445 | 347 | 365 | 355 | 405 | 362 |
| 21 | | | 446 | 340 | 365 | 358 | 406 | 355 |
| 23 | | | 444 | 344 | 367 | 360 | 408 | 358 |
| 25 | | | 445 | 346 | 365 | 362 | 405 | 364 |
| 28 | | | 439 | 340 | 365 | 351 | 407 | 352 |
| 30 | 27 | 3100 | 446 | 345 | 367 | 358 | 408 | 352 |
| | | | | | | | | |
| Peak Cylinder Temp: | | | 447 | 347 | 370 | 360 | 409 | 364 |
| Note: | | Washer Type Thermocouple | | | | | | |
| | | Temperature at Cylinder Head | | | | | | |
| | | Max. Allowable: 530°F. | | | | | | |

TABLE 2

H-23C Filter Installation - Clean Cartridge

TEST TO DETERMINE HIGHEST CYLINDER HEAD TEMPERATURE

DATE 19 July 1960 WIND VELOCITY 6 KTS

OUTSIDE AIR TEMPERATURE 93°F. BAR. PRESSURE 30.04

REL. HUMIDITY 70%

DESCRIPTION: Hover at gross weight (2500 lbs.) and maximum power at 50 ft. P.A.

| Time (Minutes) | MP In. Hg. | RPM | CYLINDER HEAD TEMPERATURE °F | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | #1 | #2 | #3 | #4 | #5 | #6 |
| 0 | 27 | 3100 | 355 | 280 | 350 | 330 | 345 | 320 |
| 1 | | | 394 | 297 | 387 | 354 | 380 | 352 |
| 2 | | | 404 | 305 | 396 | 369 | 390 | 362 |
| 3 | | | 407 | 311 | 405 | 375 | 400 | 367 |
| 4 | | | 411 | 312 | 412 | 384 | 412 | 367 |
| 5 | | | 415 | 314 | 414 | 385 | 413 | 371 |
| 6 | | | 415 | 316 | 414 | 391 | 411 | 372 |
| 7 | | | 416 | 316 | 415 | 397 | 413 | 371 |
| 8 | | | 417 | 317 | 416 | 399 | 410 | 374 |
| 9 | | | 418 | 318 | 416 | 400 | 411 | 375 |
| 10 | | | 420 | 315 | 416 | 400 | 415 | 377 |
| 11 | | | 422 | 316 | 418 | 405 | 416 | 377 |
| 12 | | | 418 | 315 | 417 | 395 | 416 | 377 |
| 13 | | | 419 | 315 | 416 | 390 | 417 | 377 |
| 14 | | | 421 | 318 | 414 | 388 | 416 | 375 |
| 15 | | | 421 | 315 | 414 | 388 | 415 | 371 |
| 16 | | | 422 | 312 | 412 | 390 | 415 | 371 |
| 17 | | | 420 | 316 | 415 | 391 | 413 | 372 |
| 18 | | | 419 | 312 | 417 | 391 | 416 | 371 |
| 19 | | | 420 | 316 | 416 | 395 | 417 | 370 |
| 20 | 27 | 3100 | 420 | 316 | 414 | 387 | 412 | 371 |
| Peak Cylinder Temp: | | | 422 | 318 | 418 | 405 | 417 | 377 |
| Note: Washer Type Thermocouple, Temp. at cyl. head, max. allow. 530° F. | | | | | | | | |

TABLE 3

TEST TO DETERMINE HIGHEST CYLINDER HEAD TEMPERATURE

DATE 19 July 1960 WIND VELOCITY 6 KTS

OUTSIDE AIR TEMPERATURE 93°F. BAR. PRESSURE 30.04

REL. HUMIDITY 70%

DESCRIPTION: Hover at gross weight (2500 lbs.) and maximum power at 50 ft. P.A.

| Time (Minutes) | MP In. Hg. | RPM | CYLINDER HEAD TEMPERATURE °F | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | #1 | #2 | #3 | #4 | #5 | #6 |
| 0 | 27 | 3100 | 360 | 277 | 348 | 335 | 352 | 321 |
| 1 | | | 402 | 307 | 390 | 362 | 379 | 360 |
| 2 | | | 417 | 308 | 403 | 385 | 388 | 370 |
| 3 | | | 421 | 312 | 409 | 395 | 394 | 373 |
| 4 | | | 424 | 310 | 411 | 388 | 397 | 374 |
| 5 | | | 427 | 310 | 410 | 389 | 400 | 374 |
| 6 | | | 425 | 312 | 415 | 387 | 404 | 374 |
| 7 | | | 423 | 315 | 417 | 393 | 410 | 375 |
| 8 | | | 426 | 314 | 418 | 396 | 413 | 375 |
| 9 | | | 425 | 322 | 422 | 381 | 417 | 374 |
| 10 | | | 420 | 320 | 424 | 389 | 417 | 373 |
| 11 | | | 417 | 320 | 419 | 382 | 422 | 368 |
| 12 | | | 405 | 319 | 417 | 375 | 415 | 366 |
| 13 | | | 420 | 320 | 418 | 384 | 418 | 369 |
| 14 | | | 426 | 314 | 425 | 380 | 422 | 370 |
| 15 | | | 412 | 322 | 414 | 375 | 414 | 368 |
| 16 | | | 417 | 315 | 415 | 375 | 416 | 375 |
| 17 | | | 415 | 317 | 413 | 375 | 416 | 373 |
| 18 | | | 412 | 317 | 414 | 368 | 412 | 370 |
| 20 | 27 | 3100 | 416 | 322 | 422 | 380 | 419 | 374 |
| Peak Cylinder Temp: | | | 427 | 322 | 425 | 396 | 422 | 375 |
| Note: | | Washer Type Thermocouple Temperature at Cylinder Head Max. Allowable 530° F. | | | | | | |

## TABLE 4

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

(6.462) B. CARBURETOR HEAT RISE

1. ROTORCRAFT SHOULD BE AT MAXIMUM TAKE-OFF WEIGHT 2500 LBS., NORMAL C.G. 81.0 INS. FROM DATUM, REF. ~~PAGE No.~~ AN-01-1B-40 ~~WT. AND BALANCE REPORT No.~~ -------; AND BE FLOWN IN LEVEL FLIGHT AT CRUISING MIXTURE SETTING IN AIR FREE OF VISIBLE MOISTURE. IF MULTI-ENGINE ROTORCRAFT, USE ENGINE WITH LEAST C.A.H.R.

| NOTE: MAY BE FLOWN AT ONLY ONE ALTITUDE IF O.A.T. OF 30 °F IS AVAILABLE | MINIMUM ALTITUDE P.A. 500 FEET | | INTERMEDIATE ALTITUDE P.A. 2000 FEET | | MAXIMUM ALTITUDE P.A. 4000 FEET | |
|---|---|---|---|---|---|---|
| | FULL THROTTLE OR M.C. POWER | 90% IAS RUN 1 | FULL THROTTLE OR M.C. POWER | 90% IAS RUN 1 | FULL THROTTLE OR M.C. POWER | 90% IAS RUN 1 |
| RUN | 1 2 | 3 4 | 1 2 | 3 4 | 1 2 | 3 4 |
| HEAT CONTROL POSITION | COLD HOT | COLD HOT | COLD HOT | COLD HOT | COLD HOT | COLD HOT |
| O.A.T. °F (CORRECTED) | 78 | 78 | 72.5 | 70.5 | 60 | 62.5 |
| C.A.T. °F (CORRECTED) | 81.5 192.5 | 82.5 207.5 | 75 194 | 72 188 | 68 189 | 63.5 188.5 |
| HEAT RISE °F | 111 | 125 | 119 | 116 | 121 | 125 |
| AIR SPEED MPH IAS | 77 | 58 | 67 | 62 | 63 | 47 |
| ENGINE RPM | 3100 | 3100 | 3100 | 3100 | 3100 | 3100 |
| M.P. (IN. HG.) | 27 | 22 | 26 | 22 | 24.5 | 20 |
| SEA LEVEL INDICATED BHP | 186 | 143.5 | 178 | 143.5 | 165 | 127 |
| [1]PRESSURE CORRECTION FACTOR | | | | | | |
| STANDARD TEMP. AT PRESS. ALT. °F | 57.2 | 57.2 | 51.8 | 51.8 | 44.78 | 44.78 |
| TEMP. CORRECTION FACTOR | .89 | .88 | .892 | .889 | .882 | .882 |
| ACTUAL BHP | 165.5 | 126.3 | 158.8 | 127.5 | 145.6 | 112 |
| % RATED BHP | 82.75 | 63.15 | 79.4 | 63.75 | 72.8 | 56 |

Test Date: 6 July 1960
Barometer: 30.16
Relative Humidity: 40%
Two runs averaged for each reading.

[1]FOR SEA LEVEL ENGINES

TABLE 5

SECTION 111, POWER PLANT OPERATION

B. Carburetor Heat Rise (Continued)

2. What Is The Minimum Required Carburetor Air Heat Rise In °F? 90

3. For Sea Level Engines Employing Conventional Venturi Carburetors:

(A) What Is The Actual Temperature Heat Rise At An Outside Air Temperature Of 30 °F At 75% M.C. Power? 132 °F (Should Be At Least 90 °F)

4. For Sea Level Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) Is A Sheltered Alternate Source Of Air Provided? ........Yes No

(B) What Is The Actual Temperature Of The Preheat Supplied To The Alternate Air Intake? __________ °F

(C) Is This Temperature At Least Equal Or Greater Than That Provided By The Engine Cooling Air Downstream Of The Cylinders? Yes No

5. For Altitude Engines Employing Conventional Venturi Carburetors: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% M.C. Power? _____ °F (Should Be At Least 120 °F)

6. For Altitude Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% M.C. Power? _____ °F (Should Be At Least 100 °F Except That If A Fluid Deicing System Is Used It Need Not Be Greater Than 40 °F)

(B) If The Temperature Heat Rise Is Under 100 °F Is A Fluid Deicing System Incorporated?...........Not Applicable Yes No

7. For Multi-Engine Rotorcraft, On Which Engine Is The Carburetor Air Heat Rise Tests Reported? N/A

(A) Is This The Engine With The Least C.A.H.R.?.............Yes No

8. Report Changes In Engine RPM And/Or M.P. Using Full Carburetor Heat (Or Maximum Recommended) With Both And Each Magnetos. N/A to helicopters

Both_________RPM; L__________RPM; R__________RPM

(A) Report Usable Quantity Deicing Fluid System_______________

(B) Is Variable Flow Rate Provided?........................ Yes No

TABLE 5

SECTION III, POWER PLANT OPERATION

B. Carburetor Heat Rise (Continued)

2. What Is The Minimum Required Carburetor Air Heat Rise In °F? 90

3. For Sea Level Engines Employing Conventional Venturi Carburetors:

(A) What Is The Actual Temperature Heat Rise At An Outside Air Temperature Of 30 °F At 75% H.C. Power? 132 °F (Should Be At Least 90 °F)

4. For Sea Level Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) Is A Sheltered Alternate Source Of Air Provided? .................... Yes No

(B) What Is The Actual Temperature Of The Preheat Supplied To The Alternate Air Intake? ________ °F

(C) Is This Temperature At Least Equal Or Greater Than That Provided By The Engine Cooling Air Downstream Of The Cylinders? Yes No

5. For Altitude Engines Employing Conventional Venturi Carburetors: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% H.C. Power? ____°F (Should Be At Least 120 °F)

6. For Altitude Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% H.C. Power? _____°F (Should Be At Least 100 °F Except That If A Fluid Deicing System Is Used It Need Not Be Greater Than 40 °F)

(B) If The Temperature Heat Rise Is Under 100 °F Is A Fluid Deicing System Incorporated? ........................Not Applicable Yes No

7. For Multi-Engine Rotorcraft, On Which Engine Is The Carburetor Air Heat Rise Tests Reported? ________________ N/A

(A) Is This The Engine With The Least C.A.H.R.? ........................ Yes No

8. Report Changes In Engine RPM And/Or H.P. Using Full Carburetor Heat (Or Maximum Recommended) With Both And Each Magnetos. N/A to helicopters

Both ____________RPM; L______________RPM; R____________RPM

(A) Report Usable Quantity Deicing Fluid System________________

(B) Is Variable Flow Rate Provided? ................................ Yes No

# ORIGINAL INSTALLATION

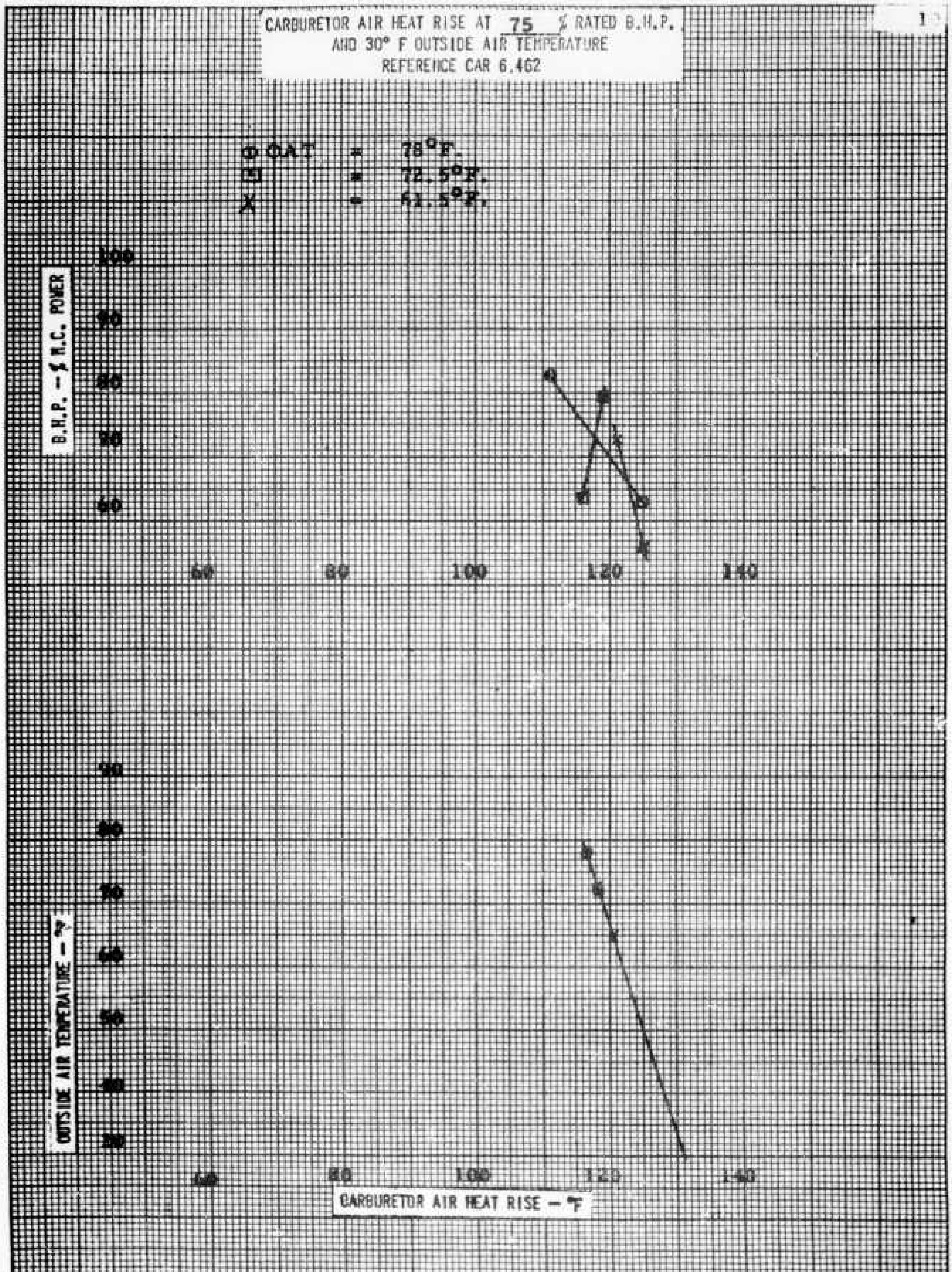

TABLE 6

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

(6.462) B. Carburetor Heat Rise

1. Rotorcraft Should Be At Maximum Take-Off Weight 2500 Lbs., Normal C.G. 81.0 Ins. From Datum, Ref. ~~Page No.~~ AN-01-1B-40 ~~Wt. And Balance Report No.~~ -------, And Be Flown In Level Flight At Cruising Mixture Setting In Air Free Of Visible Moisture. If Multi-Engine Rotorcraft, Use Engine With Least C.A.H.R.

| NOTE: May Be Flown At Only One Altitude If O.A.T. Of 30 °F Is Available | Minimum Altitude P.A. 500 Feet | | Intermediate Altitude P.A. 2000 Feet | | Maximum Altitude P.A. 5000 Feet | |
|---|---|---|---|---|---|---|
| | Full Throttle Or M.C. Power | 90% IAS Run 1 | Full Throttle Or M.C. Power | 90% IAS Run 1 | Full Throttle Or M.C. Power | 90% IAS Run 1 |
| Run | 1 2 | 3 4 | 1 2 | 3 4 | 1 2 | 3 4 |
| Heat Control Position | Cold Hot | Cold Hot | Cold Hot | Cold Hot | Cold Hot | Cold Hot |
| O.A.T. °F (Corrected) | 83 | 84 | 77.5 | 77.5 | 65.5 | 64 |
| C.A.T. °F (Corrected) | 90.5 189 | 90 188 | 83 180.5 | 83.5 183 | 76 175.5 | 77.5 180 |
| Heat Rise °F | 98.5 | 98 | 97.5 | 99.5 | 99.5 | 102.5 |
| Air Speed MPH IAS | 72.5 | 60.5 | 71.5 | 64.5 | 55 | 48 |
| Engine RPM | 3100 | 3100 | 3100 | 3100 | 3100 | 3100 |
| M.P. (In. Hg.) | 27 | 22 | 26 | 22 | 23 | 20 |
| Sea Level Indicated BHP | 186 | 143.5 | 178 | 143.5 | 152 | 127 |
| Pressure Correction Factor[1] | | | | | | |
| Standard Temp. At Press. Alt. °F | 57.2 | 57.2 | 51.8 | 51.8 | 41.18 | 41.18 |
| Temp. Correction Factor | .892 | .893 | .893 | .892 | .888 | .885 |
| Actual BHP | 166 | 128 | 159 | 128 | 135 | 112.4 |
| % Rated BHP | 83 | 64 | 79.5 | 64 | 67.5 | 56.2 |

Test Date: 6 July 1960
Barometer: 29.98
Relative Humidity: 65%
Two runs averaged for each reading.

[1] For Sea Level Engines

TABLE 7

SECTION III, POWER PLANT OPERATION

B. Carburetor Heat Rise (Continued)

2. What Is The Minimum Required Carburetor Air Heat Rise In °F? 90

3. For Sea Level Engines Employing Conventional Venturi Carburetors:

(A) What Is The Actual Temperature Heat Rise At An Outside Air Temperature Of 30 °F At 75% M.C. Power? 96 °F (Should Be At Least 90 °F)

4. For Sea Level Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) Is A Sheltered Alternate Source Of Air Provided? .................. Yes No

(B) What Is The Actual Temperature Of The Preheat Supplied To The Alternate Air Intake? ________ °F

(C) Is This Temperature At Least Equal Or Greater Than That Provided By The Engine Cooling Air Downstream Of The Cylinders? Yes No

5. For Altitude Engines Employing Conventional Venturi Carburetors: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% M.C. Power? ____°F (Should Be At Least 120 °F)

6. For Altitude Engines Employing Carburetors Which Embody Features Tending To Reduce The Possibility Of Ice Formation: N/A

(A) What Is The Actual Temperature Heat Rise At An Outside Temperature Of 30 °F At 75% M.C. Power? _____°F (Should Be At Least 100 °F Except That If A Fluid Deicing System Is Used It Need Not Be Greater Than 40 °F)

(B) If The Temperature Heat Rise Is Under 100 °F Is A Fluid Deicing System Incorporated? ..........................Not Applicable Yes No

7. For Multi-Engine Rotorcraft, On Which Engine Is The Carburetor Air Heat Rise Tests Reported? N/A

(A) Is This The Engine With The Least C.A.H.R.? ........................ Yes No

8. Report Changes In Engine RPM And/Or H.P. Using Full Carburetor Heat (Or Maximum Recommended) With Both And Each Magnetos. N/A to helicopters

Both ____________RPM; L ________________RPM; R ______________RPM

(A) Report Usable Quantity Deicing Fluid System ________________

(B) Is Variable Flow Rate Provided? .................................. Yes No

## H-23C INSTALLATION - CLEAN CARTRIDGE

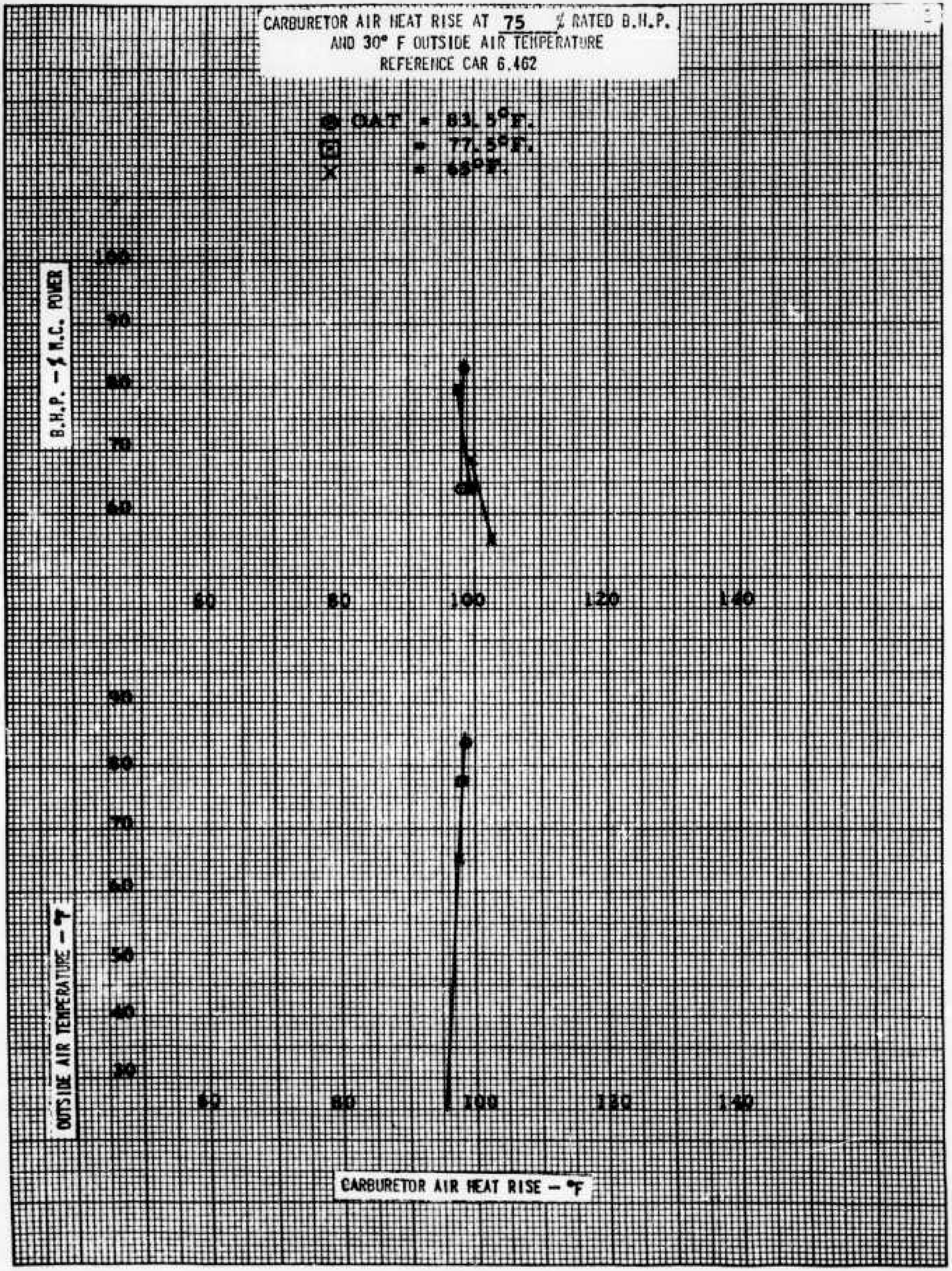

TABLE 8

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Filter Restricted to 10" $H_2O$

(6.462) B. CARBURETOR HEAT RISE

1. ROTORCRAFT SHOULD BE AT MAXIMUM TAKE-OFF WEIGHT 2500 LBS., NORMAL C.G. 81.0 INS. FROM DATUM, REF. ~~PAGE NO.~~ AN-01-1B-40 ~~WT. AND BALANCE REPORT NO.~~ -------, AND BE FLOWN IN LEVEL FLIGHT AT CRUISING MIXTURE SETTING IN AIR FREE OF VISIBLE MOISTURE. IF MULTI-ENGINE ROTORCRAFT, USE ENGINE WITH LEAST C.A.H.R.

| NOTE: MAY BE FLOWN AT ONLY ONE ALTITUDE IF O.A.T. OF 30 °F IS AVAILABLE | MINIMUM ALTITUDE P.A. 500 FEET | | | | INTERMEDIATE ALTITUDE P.A. 2000 FEET | | | | MAXIMUM ALTITUDE P.A. 5000 FEET | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FULL THROTTLE OR M.C. POWER | | 90% IAS RUN 1 | | FULL THROTTLE OR M.C. POWER | | ~~90% IAS~~ RUN 1 | | FULL THROTTLE OR M.C. POWER | | 90% IAS RUN 1 | |
| RUN | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| HEAT CONTROL POSITION | COLD | HOT | COLD | HOT | COLD | HOT | COLD | HOT | COLD | HOT | COLD | HOT |
| O.A.T. °F (CORRECTED) | 85 | | 84 | | 75.5 | | 74.5 | | 62 | | 62.5 | |
| C.A.T. °F (CORRECTED) | 92 | 195 | 88 | 202 | 79 | 194 | 79 | 186.5 | 68.5 | 174 | 70 | 177.5 |
| HEAT RISE °F | 103 | | 94 | | 115 | | 107.5 | | 115.5 | | 107.5 | |
| AIR SPEED MPH IAS | 63 | | 53.5 | | 67.5 | | 61.5 | | 62 | | 48.5 | |
| ENGINE RPM | 3100 | | 3100 | | 3100 | | 3100 | | 3100 | | 3100 | |
| M.P. (IN. HG.) | 27 | | 22.5 | | 26 | | 21.5 | | 23 | | 20 | |
| SEA LEVEL INDICATED BHP | 186 | | 148 | | 178 | | 139.5 | | 152 | | 127 | |
| [1]PRESSURE CORRECTION FACTOR | | | | | | | | | | | | |
| STANDARD TEMP. AT PRESS. ALT. °F | 57.2 | | 57.2 | | 51.8 | | 51.8 | | 41.18 | | 41.18 | |
| TEMP. CORRECTION FACTOR | .889 | | .885 | | .885 | | .89 | | .89 | | .886 | |
| ACTUAL BHP | 165.4 | | 131 | | 157.5 | | 124 | | 135.2 | | 112.5 | |
| % RATED BHP | 82.7 | | 65.5 | | 78.75 | | 62 | | 67.6 | | 56.25 | |

Test Date: 17 July 1960
Barometer: 30.10
Relative Humidity: 55%
Two runs averaged for each reading.

[1]FOR SEA LEVEL ENGINES

TABLE 9

SECTION III, POWER PLANT OPERATION

B. CARBURETOR HEAT RISE (CONTINUED)

2. WHAT IS THE MINIMUM REQUIRED CARBURETOR AIR HEAT RISE IN °F? 90°F.

3. FOR SEA LEVEL ENGINES EMPLOYING CONVENTIONAL VENTURI CARBURETORS:

(A) WHAT IS THE ACTUAL TEMPERATURE HEAT RISE AT AN OUTSIDE AIR TEMPERATURE OF 30 °F AT 75% M.C. POWER? 154 °F (SHOULD BE AT LEAST 90 °F)

4. FOR SEA LEVEL ENGINES EMPLOYING CARBURETORS WHICH EMBODY FEATURES TENDING TO REDUCE THE POSSIBILITY OF ICE FORMATION: N/A

(A) IS A SHELTERED ALTERNATE SOURCE OF AIR PROVIDED? .................. YES NO

(B) WHAT IS THE ACTUAL TEMPERATURE OF THE PREHEAT SUPPLIED TO THE ALTERNATE AIR INTAKE? ________ °F

(C) IS THIS TEMPERATURE AT LEAST EQUAL OR GREATER THAN THAT PROVIDED BY THE ENGINE COOLING AIR DOWNSTREAM OF THE CYLINDERS? YES NO

5. FOR ALTITUDE ENGINES EMPLOYING CONVENTIONAL VENTURI CARBURETORS: N/A

(A) WHAT IS THE ACTUAL TEMPERATURE HEAT RISE AT AN OUTSIDE TEMPERATURE OF 30 °F AT 75% M.C. POWER? ____°F (SHOULD BE AT LEAST 120 °F)

6. FOR ALTITUDE ENGINES EMPLOYING CARBURETORS WHICH EMBODY FEATURES TENDING TO REDUCE THE POSSIBILITY OF ICE FORMATION: N/A

(A) WHAT IS THE ACTUAL TEMPERATURE HEAT RISE AT AN OUTSIDE TEMPERATURE OF 30 °F AT 75% M.C. POWER? _____°F (SHOULD BE AT LEAST 100 °F EXCEPT THAT IF A FLUID DEICING SYSTEM IS USED IT NEED NOT BE GREATER THAN 40 °F)

(B) IF THE TEMPERATURE HEAT RISE IS UNDER 100 °F IS A FLUID DEICING SYSTEM INCORPORATED? ..........................NOT APPLICABLE YES NO

7. FOR MULTI-ENGINE ROTORCRAFT, ON WHICH ENGINE IS THE CARBURETOR AIR HEAT RISE TESTS REPORTED? N/A

(A) IS THIS THE ENGINE WITH THE LEAST C.A.H.R.? ........................ YES NO

8. REPORT CHANGES IN ENGINE RPM AND/OR H.P. USING FULL CARBURETOR HEAT (OR MAXIMUM RECOMMENDED) WITH BOTH AND EACH MAGNETOS. N/A to helicopters

BOTH ____________RPM; L_______________RPM; R_____________RPM

(A) REPORT USABLE QUANTITY DEICING FLUID SYSTEM________________

(B) IS VARIABLE FLOW RATE PROVIDED? ................................. YES NO

H-23C INSTALLATION - RESTRICTED CARTRIDGE

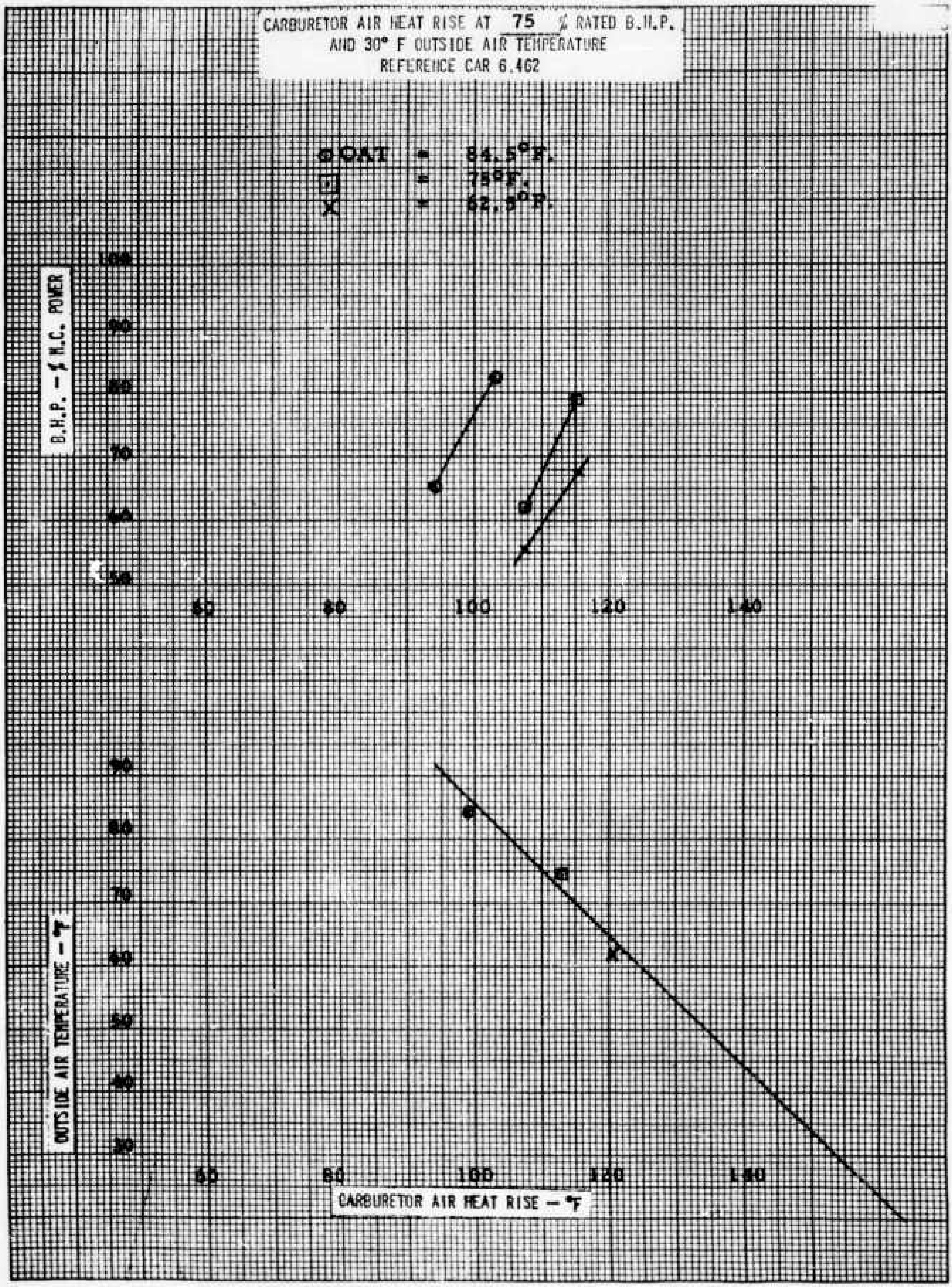

TABLE 10

SECTION III, POWER PLANT OPERATION

Original Mixing
Box Installation

(6.450) (6.451) C. COOLING:

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REV. PAGE NO.~~ ----- ~~WT. AND BALANCE REPORT NO.~~ Ref; AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
............................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? __________

| | TIME | PRESSURE ALTITUDE | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | SPEED OF CLIMB M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (MINUTES) | (FT.) | O.A.T. | HEAD | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T.°F | I.A.S. | C.A.S. |
| un 1 | 1 | 0 | 87 | 238 | | 149 | 27 | 3100 | 89 | 47 | 45 |
| | 2 | 400 | 82 | 350 | | 158 | 27 | 3100 | 95 | 47 | 45 |
| | 3 | 600 | 79 | 353 | | 158 | 27 | 3100 | 90 | 47 | 45 |
| | 4 | 800 | 78 | 418 | | 176 | 26.5 | 3100 | 88 | 47 | 45 |
| | 5 | 1700 | 75 | 420 | | 167 | 26 | 3100 | 82 | 47 | 45 |
| | | | | | | | | | | | |
| Run 2 | 1 | 0 | 80 | 420 | | 206 | 27 | 3100 | 92 | 47 | 45 |
| | 2 | 300 | 81 | 434 | | 206 | 27 | 3100 | 89 | 47 | 45 |
| | 3 | 800 | 77 | 435 | | 205 | 26.5 | 3100 | 83 | 47 | 45 |
| | 4 | 1200 | 76 | 446 | | 204 | 26 | 3100 | 84 | 47 | 45 |
| | 5 | 1800 | 73 | 432 | | 197 | 26 | 3100 | 82 | 47 | 45 |
| | | | | | | | | | | | |

Cylinder #1
Washer Type
Thermocouple

Test Date: 5 July 1960
Wind: 6 KTS Max.
Relative Humidity: 60%
Barometer: 30.18

TABLE 10 (CONT.)

SECTION 111, POWER PLANT OPERATION — Original Mixing Box Installation

C. Cooling (Continued)

1. During Climb In Air Free Of Visible Hoistune (Continued)

(G) What Is Hottest Cylinder Head? #1 And On Which Engine? ______

(H) What Is Hottest Cylinder Barrel? N/A And On Which Engine? ______

(I) Which Engine Has Highest Oil Inlet Temperature? N/A

(J) For Sea Level Engines, Single Engine Rotorcraft:
After Engine Temperatures Have Stabilized In Flight, Start At Lowest Practicable Altitude And Climb For One Minute At Take-Off Power; Continue Climb At Full Throttle Until At Least 5 Minutes ~~After-The-Occurrence-Of-The-Highest-Temperature~~ or 2000 ft.*
Recorded:
(1) Is Climb Conducted At The Best R/C Speed?.(41.KTS)....No (Yes)
A. If "No", What Is Speed? ______ MPH IAS; ______ MPH CAS

(K) For Supercharged Engines, Single Engine Rotorcraft:
After Engine Temperatures Have Stabilized In Flight, Tests Should Start At 1,000 Feet Below The Actual Engine Critical Altitude And Continue At Least 5 Minutes After The Occurrence Of The Highest Temperature Recorded:
(1) Is Climb Conducted At The Best R/C Speed?......N/A....No Yes
A. If "No", What Is Speed? ______ MPH IAS; ______ MPH CAS

(L) For Multi Engine Rotorcraft, One Engine Inoperative Climb Performance: N/A
With The Rotorcraft In The Configuration That Was Used In Establishing The Critical Engine Inoperative Climb Performance, The Operating Engine(s) At M.C. Power Or At Full Throttle And After The Temperatures Are Stabilized in Flight, Climb Should Be Started At The Lower Of the Two Following Altitudes And Continued For 5 Minutes After The First Occurrence Of The Highest Temperature:

1,000 Feet Below The Actual Engine Critical Altitude
Or The Lowest Practicable Altitude (When Applicable).

(1) Is Climb Conducted At The Speed Used in Establishing The One Engine Inoperative Climb Performance?..........No Yes

* Per FAA TIA No. H353-18
30 April 1959

TABLE 10 (CONT.)

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

C. COOLING (CONTINUED)

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? #1 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

(J) FOR SEA LEVEL ENGINES, SINGLE ENGINE ROTORCRAFT:
AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT, START AT LOWEST PRACTICABLE ALTITUDE AND CLIMB FOR ONE MINUTE AT TAKE-OFF POWER; CONTINUE CLIMB AT FULL THROTTLE UNTIL AT LEAST 5 MINUTES ~~AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE~~ or 2000 ft.* RECORDED:

(1) IS CLIMB CONDUCTED AT THE BEST R/C SPEED? .(41 KTS)....... NO (YES)
A. IF "NO", WHAT IS SPEED? ________ MPH IAS; ________ MPH CAS

(K) FOR SUPERCHARGED ENGINES, SINGLE ENGINE ROTORCRAFT:
AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT, TESTS SHOULD START AT 1,000 FEET BELOW THE ACTUAL ENGINE CRITICAL ALTITUDE AND CONTINUE AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED:

(1) IS CLIMB CONDUCTED AT THE BEST R/C SPEED? ......N/A........ NO YES
A. IF "NO", WHAT IS SPEED? ________ MPH IAS; ________ MPH CAS

(L) FOR MULTI-ENGINE ROTORCRAFT, ONE ENGINE INOPERATIVE CLIMB PERFORMANCE: N/A
WITH THE ROTORCRAFT IN THE CONFIGURATION THAT WAS USED IN ESTABLISHING THE CRITICAL ENGINE INOPERATIVE CLIMB PERFORMANCE, THE OPERATING ENGINE(S) AT M.C. POWER OR AT FULL THROTTLE AND AFTER THE TEMPERATURES ARE STABILIZED IN FLIGHT, CLIMB SHOULD BE STARTED AT THE LOWER OF THE TWO FOLLOWING ALTITUDES AND CONTINUED FOR 5 MINUTES AFTER THE FIRST OCCURRENCE OF THE HIGHEST TEMPERATURE:

1,000 FEET BELOW THE ACTUAL ENGINE CRITICAL ALTITUDE OR THE LOWEST PRACTICABLE ALTITUDE (WHEN APPLICABLE).

(1) IS CLIMB CONDUCTED AT THE SPEED USED IN ESTABLISHING THE ONE ENGINE INOPERATIVE CLIMB PERFORMANCE? .................. NO YES

* Per FAA TIA No. H353-18
30 April 1959

TABLE 11

SECTION III, POWER PLANT OPERATION

Original Mixing
Box Installation

C. Cooling (Continued)

1. During Climb In Air Free Of Visible Moisture (Continued)

(H) Temperature Values And Correction:

(Run 2)

| Line No. | Item | | Cylinder Head (No. 1) | Cylinder Base (No.___) | Oil Inlet |
|---|---|---|---|---|---|
| (1) | Maximum Observed Temperature | °F | 446 | | 206 |
| (2) | True Observed Temperature | °F | 446 | | 206 |
| (3) | Pressure Altitude At Which Temp. Stabilizes Or Final Peak Occurs | Ft. | 1200 | | 300 |
| (4) | Observed O.A.T. Air Temperature At (3) | °F | 76 | | 81 |
| (5) | True O.A.T. Air Temperature At (3) | °F | 76 | | 81 |
| (6) | .0036 X (3) | | 3.32 | | 1.08 |
| (7) | Standard Hot Day Temperature At (3) = 100 − (6) | °F | 96.68 | | 79.92 |
| (8) | $\Delta$T = (7) − (5) | °F | 20.68 | | -1.08 |
| (9A) | Temperature Correction Increment (Head & Oil) = 1.0 X (8) | °F | 20.68 | X | -1.08 |
| (9B) | Temperature Correction Increment (Base) = .7 X (8) | °F | X | | X |
| (10) | Corrected Temperature = (2) + (9) | °F | 466.68 | | 204.92 |
| (11) | Maximum Permissible Temperature (Washer) | °F | 530 | | 230 |
| (12) | Cooling Margin = (11) − (10) | °F | 63.32 | | 25.08 |
| (13) | Is Cooling Satisfactory? | | Yes | Yes | Yes |

(6.100(a)) (N) Are All Calibration Curves Attached? .................................. (Yes) No

2. During Hovering In Air Free Of Visible Moisture:

(A) Take-Off Weight (Max.) 2500 Lbs.; C.G. 81.0 Ins. From Datum;
~~Ref. Page No. -------; Wt. And Balance Report No.~~ Ref: AN-01-18-40

(B) Fuel Octane No. 100/130 (Minimum Approved For Engine)

TABLE 12

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

(6.450) C. COOLING:
(6.451)

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REV. PAGE NO.~~ -----, ~~WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
............................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ____________

| | TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | SPEED OF CLIMB M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | O.A.T. | HEAD | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T.°F | I.A.S. | C.A.S. |
| Run 1 | 1 | 300 | 84 | 410 | | 194 | 27 | 3100 | 98 | 47 | 45 |
| | 2 | 750 | 83 | 430 | | 194 | 27 | 3100 | 87 | 47 | 45 |
| | 3 | 1000 | 80 | 431 | | 194 | 27 | 3100 | 82 | 47 | 45 |
| | 4 | 1300 | 77 | 435 | | 196 | 27 | 3100 | 81 | 47 | 45 |
| | 5 | 1700 | 77 | 438 | | 194 | 27 | 3100 | 81 | 47 | 45 |
| | 6 | 2000 | 74 | 422 | | 194 | 27 | 3100 | 77 | 47 | 45 |
| Run 2 | 1 | 0 | 84 | 378 | | 181 | 27 | 3100 | 86 | 47 | 45 |
| | 2 | 300 | 81 | 416 | | 193 | 27 | 3100 | 88 | 47 | 45 |
| | 3 | 650 | 80 | 427 | | 193 | 27 | 3100 | 84 | 47 | 45 |
| | 4 | 1000 | 75 | 431 | | 194 | 27 | 3100 | 81 | 47 | 45 |
| | 5 | 1500 | 76 | 436 | | 194 | 27 | 3100 | 81 | 47 | 45 |
| | 6 | 2000 | 72 | 430 | | 194 | 27 | 3100 | 78 | 47 | 45 |

Cylinder #5
Washer Type
Thermocouple

Test Date: 16 July 1960
Wind: 6 KTS Max.
Relative Humidity: 57%
Barometer: 30.11

TABLE 12 (CONT.)

SECTION 111, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. Cooling (Continued)

1. During Climb In Air Free Of Visible Moisture (Continued)

(G) What Is Hottest Cylinder Head? #5 And On Which Engine? ________

(H) What Is Hottest Cylinder Barrel? N/A And On Which Engine? ______

(I) Which Engine Has Highest Oil Inlet Temperature? N/A

(J) For Sea Level Engines, Single Engine Rotorcraft:
After Engine Temperatures Have Stabilized In Flight, Start At Lowest Practicable Altitude And Climb For One Minute At Take-Off Power; Continue Climb At Full Throttle Until At Least 5-Minutes ~~After-The-Occurrence-Of-The-Highest-Temperature~~ or 2000 ft. *
Recorded:
(1) Is Climb Conducted At The Best R/C Speed? .(41.KTS)... No (Yes)
A. If "No", What Is Speed? ________MPH IAS; ______MPH CAS

(K) For Supercharged Engines, Single Engine Rotorcraft:
After Engine Temperatures Have Stabilized In Flight, Tests Should Start At 1,000 Feet Below The Actual Engine Critical Altitude And Continue At Least 5 Minutes After The Occurrence Of The Highest Temperature Recorded: N/A
(1) Is Climb Conducted At The Best R/C Speed? ...............No Yes
A. If "No", What Is Speed? ________MPH IAS; ______MPH CAS

(L) For Multi-Engine Rotorcraft, One Engine Inoperative Climb Performance:
With The Rotorcraft In The Configuration That Was Used In Establishing The Critical Engine Inoperative Climb Performance, The Operating Engine(s) At M.C. Power Or At Full Throttle And After The Temperatures Are Stabilized In Flight, Climb Should Be Started At The Lower Of The Two Following Altitudes And Continued For 5 Minutes After The First Occurrence Of The Highest Temperature:

1,000 Feet Below The Actual Engine Critical Altitude N/A
Or The Lowest Practicable Altitude (When Applicable).

(1) Is Climb Conducted At The Speed Used In Establishing The One Engine Inoperative Climb Performance?............No Yes

* Per FAA TIA No H353-18
30 April 1959

TABLE 13

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. COOLING (CONTINUED)

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(H) TEMPERATURE VALUES AND CORRECTION:

Run #1

| LINE No. | ITEM | | CYLINDER HEAD (No. 5) | CYLINDER BASE (No.____) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 438 | | 196 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 438 | | 196 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 1700 | | 1300 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 77 | | 77 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 77 | | 77 |
| (6) | .0036 X (3) | | 6.12 | | 4.68 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 94.88 | | 95.32 |
| (8) | $\Delta$T = (7) − (5) | °F | 17.88 | | 18.32 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 17.88 | | 18.32 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | | | |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 455.88 | | 214.32 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE (Washer) | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 44.12 | | 15.68 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (N) ARE ALL CALIBRATION CURVES ATTACHED? .............................. (YES) No

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REF. PAGE NO.________; WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

TABLE 14

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Restricted to 10" $H_2O$

(6.450)
(6.451) C. COOLING:

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REF. PAGE NO.~~ -----, ~~WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
..........................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ____________

| | TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | SPEED OF CLIMB M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | O.A.T. | HEAD | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T.°F | I.A.S. | C.A.S. |
| Run 1 | 1 | 100 | 88 | 392 | | 176 | 27 | 3100 | 104 | 47 | 45 |
| | 2 | 400 | 86 | 405 | | 180 | 27 | 3100 | 99 | 47 | 45 |
| | 3 | 750 | 84 | 411 | | 181 | 27 | 3100 | 98 | 47 | 45 |
| | 4 | 1200 | 80 | 407 | | 181 | 26.5 | 3100 | 93 | 47 | 45 |
| | 5 | 1800 | 77 | 403 | | 190 | 26.5 | 3100 | 91 | 47 | 45 |
| | 6 | 2000 | 77 | 404 | | 190 | 26.5 | 3100 | 88 | 47 | 45 |
| Run 2 | 1 | 0 | 88 | 366 | | 180 | 27 | 3100 | 103 | 47 | 45 |
| | 2 | 0 | 88 | 390 | | 192 | 26.5 | 3100 | 104 | 47 | 45 |
| | 3 | 300 | 85 | 406 | | 192 | 26.5 | 3100 | 96 | 47 | 45 |
| | 4 | 750 | 83 | 410 | | 194 | 26 | 3100 | 94 | 47 | 45 |
| | 5 | 1300 | 79 | 408 | | 194 | 26 | 3100 | 90 | 47 | 45 |
| | 6 | 1800 | 77 | 406 | | 194 | 26 | 3100 | 87 | 47 | 45 |

Cylinder #5
Washer Type
Thermocouple

Test Date: 18 July 1960
Wind: 6 KTS Max.
Relative Humidity: 64.9%
Barometer: 30.02

SECTION III, POWER PLANT OPERATION

H-23C - Filter Installation
Restricted to 10" $H_2O$

C. COOLING (CONTINUED)

1. DURING CLIMB IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? #5 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

(J) FOR SEA LEVEL ENGINES, SINGLE ENGINE ROTORCRAFT:
AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT, START AT LOWEST PRACTICABLE ALTITUDE AND CLIMB FOR ONE MINUTE AT TAKE-OFF POWER; CONTINUE CLIMB AT FULL THROTTLE UNTIL AT LEAST 5 MINUTES ~~AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE~~ or 2000 Ft.* RECORDED:

(1) IS CLIMB CONDUCTED AT THE BEST R/C SPEED? (41 KTS) .......... NO (YES)
A. IF "NO", WHAT IS SPEED? ________ MPH IAS; ________ MPH CAS

(K) FOR SUPERCHARGED ENGINES, SINGLE ENGINE ROTORCRAFT:
AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT, TESTS SHOULD START AT 1,000 FEET BELOW THE ACTUAL ENGINE CRITICAL ALTITUDE AND CONTINUE AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED: N/A

(1) IS CLIMB CONDUCTED AT THE BEST R/C SPEED? .................... NO YES
A. IF "NO", WHAT IS SPEED? ________ MPH IAS; ________ MPH CAS

(L) FOR MULTI-ENGINE ROTORCRAFT, ONE ENGINE INOPERATIVE CLIMB PERFORMANCE:
WITH THE ROTORCRAFT IN THE CONFIGURATION THAT WAS USED IN ESTABLISHING THE CRITICAL ENGINE INOPERATIVE CLIMB PERFORMANCE, THE OPERATING ENGINE(S) AT M.C. POWER OR AT FULL THROTTLE AND AFTER THE TEMPERATURES ARE STABILIZED IN FLIGHT, CLIMB SHOULD BE STARTED AT THE LOWER OF THE TWO FOLLOWING ALTITUDES AND CONTINUED FOR 5 MINUTES AFTER THE FIRST OCCURRENCE OF THE HIGHEST TEMPERATURE: N/A

1,000 FEET BELOW THE ACTUAL ENGINE CRITICAL ALTITUDE OR THE LOWEST PRACTICABLE ALTITUDE (WHEN APPLICABLE).

(1) IS CLIMB CONDUCTED AT THE SPEED USED IN ESTABLISHING THE ONE ENGINE INOPERATIVE CLIMB PERFORMANCE? .................. NO YES

* Per FAA TIA No. H353-18
30 April 1959

TABLE 15

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Restricted to 10" $H_2O$

C. Cooling (Continued)

1. During Climb In Air Free Of Visible Moisture (Continued)

(M) Temperature Values And Correction:

Run #1

| Line No. | Item | | Cylinder Head (No. 5) | Cylinder Base (No. ) | Oil Inlet |
|---|---|---|---|---|---|
| (1) | Maximum Observed Temperature | °F | 411 | | 190 |
| (2) | True Observed Temperature | °F | 411 | | 190 |
| (3) | Pressure Altitude At Which Temp. Stabilizes Or Final Peak Occurs | Ft. | 750 | | 1800 |
| (4) | Observed O.A.T. Air Temperature At (3) | °F | 84 | | 77 |
| (5) | True O.A.T. Air Temperature At (3) | °F | 84 | | 77 |
| (6) | .0036 X (3) | | 2.7 | | 6.05 |
| (7) | Standard Hot Day Temperature At (3) = 100 − (6) | °F | 97.3 | | 93.95 |
| (8) | $\Delta$T = (7) − (5) | °F | 13.3 | | 16.95 |
| (9A) | Temperature Correction Increment (Head & Oil) = 1.0 X (8) | °F | 13.3 | X | 16.95 |
| (9B) | Temperature Correction Increment (Base) = .7 X (8) | °F | X | | X |
| (10) | Corrected Temperature = (2) + (9) | °F | 424.3 | | 206.95 |
| (11) | Maximum Permissible Temperature(washer) | °F | 530 | | 230 |
| (12) | Cooling Margin = (11) − (10) | °F | 105.7 | | 23.05 |
| (13) | Is Cooling Satisfactory? | | Yes | Yes | Yes |

(6.100(a)) (N) Are All Calibration Curves Attached? .............................. (Yes) No

2. During Hovering In Air Free Of Visible Moisture:

(A) Take-Off Weight (Max.) 2500 Lbs.; C.G. 81.0 Ins. From Datum; ~~Ref. Page No.--------; Wt. And Balance Report No.~~ Ref: AN-01-1B-40

(B) Fuel Octane No. 100/130 (Minimum Approved For Engine)

TABLE 16

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation
Note: Wt. 2500 (Max.)

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ..........................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ________

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 84 | 433 | | 176 | 27 | 3100 | 99 |
| 1 | | 85 | 439 | | 180 | | | 98 |
| 3 | | 85 | 449 | | 194 | | | 99 |
| 4 | | 84 | 465 | | 197 | | | 98 |
| 6 | | 83 | 455 | | 203 | | | 97 |
| 7 | | 84 | 454 | | 208 | | | 100 |
| 9 | | 83 | 453 | | 210 | | | 98 |
| 10 | | 84 | 457 | | 210 | | | 96 |
| 11 | | 83 | 457 | | 212 | | | 100 |
| 13 | | 84 | 458 | | 212 | | | 98 |
| 14 | | 84 | 455 | | 212 | | | 97 |
| 15 | 50 | 84 | 453 | | 212 | 27 | 3100 | 99 |

* Washer Type Thermocouple

Test Date: 5 July 1960
Wind: 4 Knots Max.
Relative Humidity: 82%
Barometer: 29.99

TABLE 17

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? #1 AND ON WHICH ENGINE? ______

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ______

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND? (WIND VELOCITY NOT TO EXCEED 10-12 MPH)..........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ______

2. NOSE INTO WIND ______

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No. ___ ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 465 | | 212 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 465 | | 212 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 84 | | 84 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 84 | | 84 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\triangle$ T = (7) − (5) | °F | 15.82 | | 15.82 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 15.82 | | 15.82 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | | | |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 481 | | 228 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 49 | | 2 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) NO

TABLE 18

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2500 (max.)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
............................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ____________________

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 82 | 404 | | 176 | 27 | 3100 | 93 |
| 1 | | 81 | 420 | | 190 | | | 94 |
| 2 | | 82 | 435 | | 194 | | | 96 |
| 3 | | 82 | 437 | | 198 | | | 96 |
| 4 | | 83 | 440 | | 200 | | | 96 |
| 5 | | 82 | 432 | | 203 | | | 92 |
| 6 | | 83 | 438 | | 206 | | | 96 |
| 7 | | 82 | 442 | | 206 | | | 99 |
| 8 | | 81 | 444 | | 210 | | | 96 |
| 9 | | 81 | 435 | | 210 | | | 98 |
| 10 | | 82 | 433 | | 212 | | | 99 |
| 11 | 50 | 83 | 432 | | 212 | 27 | 3100 | 94 |

*Washer Type
Thermocouple

Test Date: 16 July 1960
Wind: 2 Knots
Relative Humidity: 57%
Barometer: 30.20

TABLE 19

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? #5 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? ________

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND?
(WIND VELOCITY NOT TO EXCEED 10-12 MPH)..........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ________

2. NOSE INTO WIND ________

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 5) | CYLINDER BASE (No. ___) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 444 | | 212 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 444 | | 212 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 81 | | 83 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 81 | | 83 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 - (6) | °F | 99.82 | | 99.82 |
| (8) | $\Delta T = (7) - (5)$ | °F | 19 | | 17 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 19 | | 17 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | | | |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 463 | | 229 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) - (10) | °F | 67 | | 1 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) NO

TABLE 20

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Restricted to 10" $H_2O$

C. Cooling (Continued)

2. During Hovering In Air Free Of Visible Moisture (Continued)

Note: Wt. 2500 (max.)

(C) Mixture Setting Full Rich

(D) Throttle Setting Full Open

(E) Shutter Position N/A

(6.613(e)) (1) For Rotorcraft Equipped With Cooling Shutters, Is A Cylinder Head Temperature Indicator Provided For Each Engine? ....... Yes No

(F) In Multi-Engine Rotorcraft, Is One Engine Inoperative? ............................................(Not Applicable) Yes No

Which Engine Is Inoperative? ____________

| Time | Pressure Altitude | Observed Temperatures °F | | | | Operating Engine(s) | | |
|---|---|---|---|---|---|---|---|---|
| (Minutes) | (Ft.) | O.A.T. | Head* | Barrel | Oil | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 87 | 415 | | 192 | 27 | 3100 | 109 |
| 1 | | 87 | 414 | | 194 | | | 105 |
| 2 | | 88 | 419 | | 198 | | | 112 |
| 3 | | 88 | 424 | | 203 | | | 111 |
| 4 | | 88 | 425 | | 208 | | | 113 |
| 5 | | 88 | 424 | | 208 | | | 112 |
| 6 | | 87 | 421 | | 210 | | | 107 |
| 7 | | 89 | 418 | | 210 | | | 109 |
| 8 | | 89 | 421 | | 210 | | | 110 |
| 10 | | 86 | 416 | | 212 | | | 108 |
| 12 | | 88 | 420 | | 210 | | | 107 |
| 14 | 50 | 87 | 420 | | 210 | 27 | 3100 | 112 |

* Washer Type Thermocouple

Test Date: 17 July 1960
Wind: 6 Knots
Relative Humidity: 57%
Barometer: 30.07

TABLE 21

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND? (WIND VELOCITY NOT TO EXCEED 10-12 MPH)..........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ________

2. NOSE INTO WIND ________

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No.____) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 425 | | 212 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 425 | | 212 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 88 | | 86 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 88 | | 86 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\triangle$ T = (7) − (5) | °F | 12 | | 14 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 12 | X | 14 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 437 | | 226 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 93 | | 4 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) No

TABLE 22

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2400 (max. less 100)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ............................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ____________

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 82 | 450 | | 206 | 26.5 | 3100 | 97 |
| 1 | | 82 | 458 | | 208 | | | 100 |
| 3 | | 83 | 465 | | 212 | | | 100 |
| 4 | | 85 | 462 | | 212 | | | 102 |
| 5 | | 84 | 463 | | 212 | | | 101 |
| 7 | | 84 | 465 | | 212 | | | 101 |
| 8 | | 85 | 466 | | 212 | | | 98 |
| 9 | | 82 | 464 | | 212 | | | 100 |
| 11 | | 84 | 459 | | 214 | | | 101 |
| 12 | | 86 | 457 | | 214 | | | 102 |
| 13 | | 84 | 465 | | 214 | | | 104 |
| 15 | 50 | 85 | 463 | | 214 | 26.5 | 3100 | 101 |

*Washer Type Thermocouple

Test Date: 5 July
Wind: 4 Knots
Relative Humidity: 82%
Barometer: 29.99

TABLE 23

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND? (WIND VELOCITY NOT TO EXCEED 10-12 MPH).........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ________

2. NOSE INTO WIND ________

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No. ____ ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 466 | | 214 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 466 | | 214 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 85 | | 85 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 85 | | 85 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\Delta T = (7) - (5)$ | °F | 15 | | 15 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 15 | | 15 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | | | |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 481 | | 229 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 49 | | 1 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) NO

TABLE 24

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2400 (max. less 100)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ............................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ____________

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | *HEAD | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 86 | 446 | | 216 | 26.5 | 3100 | 98 |
| 1 | | 86 | 440 | | 221 | | | 99 |
| 2 | | 86 | 435 | | 216 | | | 97 |
| 3 | | 86 | 432 | | 216 | | | 97 |
| 4 | | 87 | 438 | | 216 | | | 97 |
| 5 | | 86 | 442 | | 214 | | | 99 |
| 6 | | 86 | 443 | | 214 | | | 96 |
| 7 | | 84 | 441 | | 214 | | | 97 |
| 8 | | 86 | 439 | | 214 | | | 99 |
| 9 | | 85 | 438 | | 212 | | | 99 |
| 10 | | 84 | 437 | | 214 | | | 101 |
| 11 | 50 | 84 | 438 | | 214 | 26.5 | 3100 | 99 |

*Washer type Thermocouple

Test Date: 16 July 1960
Wind: 3 KTS
Relative Humidity: 57%
Barometer: 30.20

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? ________

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND? (WIND VELOCITY NOT TO EXCEED 10-12 MPH)..........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ________

2. NOSE INTO WIND ________

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE NO. | ITEM | | CYLINDER HEAD (NO. 1) | CYLINDER BASE (NO. ___) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 443 | | 216 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 443 | | 216 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 86 | | 86 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 86 | | 86 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\triangle T = (7) - (5)$ | °F | 14 | | 14 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 14 | X | 14 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 457 | | 230 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 73 | | Ø |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | (YES) |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) NO

TABLE 26

**SECTION III, POWER PLANT OPERATION**

H-23C Filter Installation
Restricted to 10" $H_2O$

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2400
(Max. less 100)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ............................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ____________

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 90 | 412 | | 195 | 27 | 3100 | 108 |
| 1 | ↓ | 90 | 412 | | 198 | ↓ | ↓ | 111 |
| 2 | | 88 | 415 | | 208 | | | 112 |
| 4 | | 90 | 413 | | 208 | | | 109 |
| 5 | | 90 | 418 | | 210 | | | 114 |
| 6 | | 92 | 415 | | 210 | | | 110 |
| 7 | | 91 | 422 | | 210 | | | 109 |
| 8 | | 93 | 421 | | 212 | | | 114 |
| 9 | | 92 | 418 | | 212 | | | 115 |
| 10 | | 90 | 420 | | 212 | | | 114 |
| 11 | | 88 | 418 | | 214 | | | 112 |
| 12 | 50 | 89 | 415 | | 214 | 27 | 3100 | 113 |

*Washer Type
Thermocouple

Test Dates: 17 July 1960
Wind: 6 Knots
Relative Humidity: 57%
Barometer: 30.07

TABLE 27

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ______

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ______

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? ______

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND?
(WIND VELOCITY NOT TO EXCEED 10-12 MPH)..........ZERO WIND (YES) NO
A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO
B. WHAT IS THIS CONDITION?
1. CROSSWIND ______
2. NOSE INTO WIND ______

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No. ___ ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 422 | | 214 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 422 | | 214 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 91 | | 88 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 91 | | 88 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\Delta$ T = (7) − (5) | °F | 9 | | 12 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 9 | X | 12 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 431 | | 226 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 99 | | 4 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? .............................. (YES) NO

TABLE 28

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

C. Cooling (Continued)

2. During Hovering In Air Free Of Visible Moisture (Continued)

(C) Mixture Setting Full Rich

Note: Wt. 2300 (max. less 200)

(D) Throttle Setting Full Open

(E) Shutter Position N/A

(6.613(e)) (1) For Rotorcraft Equipped With Cooling Shutters, Is A Cylinder Head Temperature Indicator Provided For Each Engine? ....... Yes No

(F) In Multi-Engine Rotorcraft, Is One Engine Inoperative? ..........................................(Not Applicable) Yes No

Which Engine Is Inoperative? ____________

| Time (Minutes) | Pressure Altitude (Ft.) | Observed Temperatures °F | | | | Operating Engine(s) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | Head* | Barrel | Oil | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 82 | 462 | | 196 | 26 | 3100 | 96 |
| 1 | | 84 | 465 | | 198 | | | 99 |
| 2 | | 83 | 468 | | 203 | | | 98 |
| 3 | | 82 | 470 | | 205 | | | 99 |
| 4 | | 83 | 469 | | 208 | | | 97 |
| 5 | | 83 | 468 | | 208 | | | 98 |
| 7 | | 83 | 470 | | 210 | | | 98 |
| 8 | | 82 | 467 | | 210 | | | 97 |
| 9 | | 82 | 468 | | 210 | | | 97 |
| 10 | | 81 | 468 | | 210 | | | 98 |
| 12 | | 82 | 467 | | 212 | | | 99 |
| 13 | 50 | 82 | 467 | | 212 | 26 | 3100 | 99 |

*Washer Type Thermocouple

Test Date: 6 July 1960
Wind: 6 Knots
Relative Humidity: 60%
Barometer: 30.18

TABLE 29

SECTION III, POWER PLANT OPERATION

C. Cooling (Continued)

2. During Hovering In Air Free Of Visible Moisture (Continued)

(G) What Is Hottest Cylinder Head? 1 And On Which Engine? ________

(H) What Is Hottest Cylinder Barrel? N/A And On Which Engine? ________

(I) Which Engine Has Highest Oil Inlet Temperature? ________

(J) After Engine Temperatures Have Stabilized In Ground Operation Or Hovering, Start Test At Take-Off Power, Reducing To Maximum Continuous Power Following Duration Of Take-Off Power Time Limit Until At Least 5 Minutes After The Occurrence Of The Highest Temperature Recorded.

(1) Is Test Conducted Hovering Tail Into The Wind?
(Wind Velocity Not To Exceed 10-12 MPH)..........Zero Wind (Yes) No

A. If "No", Is Another Condition Deemed Critical? ........... Yes No

B. What Is This Condition?

1. Crosswind ________

2. Nose Into Wind ________

(K) Temperature Values And Correction:

| Line No. | Item | | Cylinder Head (No. 1) | Cylinder Base (No. ___) | Oil Inlet |
|---|---|---|---|---|---|
| (1) | Maximum Observed Temperature | °F | 470 | | 212 |
| (2) | True Observed Temperature | °F | 470 | | 212 |
| (3) | Pressure Altitude At Which Temp. Stabilizes Or Final Peak Occurs | Ft. | 50 | | 50 |
| (4) | Observed O.A.T. Air Temperature At (3) | °F | 82 | | 82 |
| (5) | True O.A.T. Air Temperature At (3) | °F | 82 | | 82 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | Standard Hot Day Temperature At (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\Delta T = (7) - (5)$ | °F | 18 | | 18 |
| (9A) | Temperature Correction Increment (Head & Oil) = 1.0 X (8) | °F | 18 | X | 18 |
| (9B) | Temperature Correction Increment (Base) = .7 X (8) | °F | X | | X |
| (10) | Corrected Temperature = (2) + (9) | °F | 488 | | 230 |
| (11) | Maximum Permissible Temperature | °F | 530 | | 230 |
| (12) | Cooling Margin = (11) − (10) | °F | 42 | | Ø |
| (13) | Is Cooling Satisfactory? | | Yes | Yes | Yes |

(6.100(e)) (L) Are All Calibration Curves Attached? ............................... (Yes) No

TABLE 30

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2300 (max. less 200)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ............................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ______

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | H.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 87 | 413 | | 180 | 26 | 3100 | 97 |
| 1 | | 86 | 422 | | 192 | | | 98 |
| 2 | | 83 | 425 | | 198 | | | 99 |
| 3 | | 84 | 429 | | 203 | | | 99 |
| 4 | | 87 | 432 | | 210 | | | 101 |
| 6 | | 87 | 435 | | 210 | | | 100 |
| 7 | | 88 | 439 | | 214 | | | 101 |
| 8 | | 90 | 445 | | 217 | | | 106 |
| 9 | | 85 | 445 | | 216 | | | 105 |
| 11 | | 87 | 444 | | 217 | | | 101 |
| 12 | | 88 | 441 | | 217 | | | 99 |
| 13 | 50 | 88 | 430 | | 217 | 26 | 3100 | 102 |

*Washer Type Thermocouple

Test Date: 16 July 1960
Wind: 6 Knots
Relative Humidity: 57%
Barometer: 30.11

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ____

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ____

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? ____

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND?
(WIND VELOCITY NOT TO EXCEED 10-12 MPH).........ZERO WIND (YES) NO

A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO

B. WHAT IS THIS CONDITION?

1. CROSSWIND ____
2. NOSE INTO WIND ____

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No. ___ ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 445 | | 217 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 445 | | 217 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 90 | | 88 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 90 | | 88 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\Delta$ T = (7) − (5) | °F | 10 | | 12 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 10 | X | 12 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 455 | | 229 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 75 | | 1 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(a)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ..............................( YES) NO

TABLE 32

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Restricted to 10" $H_2O$

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(C) MIXTURE SETTING Full Rich

Note: Wt. 2300
(max. less 200)

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ...... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE? ............................................(NOT APPLICABLE) YES NO

WHICH ENGINE IS INOPERATIVE? ______

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | |
|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "Hg | R.P.M. | C.A.T. °F |
| 0 | 50 | 88 | 412 | | 207 | 26.5 | 3100 | 113 |
| 1 | | 89 | 410 | | 210 | | | 112 |
| 2 | | 89 | 415 | | 208 | | | 112 |
| 4 | | 87 | 415 | | 210 | | | 109 |
| 5 | | 90 | 416 | | 210 | | | 111 |
| 6 | | 91 | 424 | | 212 | | | 114 |
| 8 | | 88 | 418 | | 212 | | | 114 |
| 10 | | 88 | 417 | | 212 | | | 113 |
| 11 | | 90 | 419 | | 214 | | | 116 |
| 12 | | 89 | 421 | | 214 | | | 115 |
| 13 | | 86 | 419 | | 212 | | | 115 |
| 14 | 50 | 86 | 415 | | 212 | 26.5 | 3100 | 112 |

*Washer Type Thermocouple

Test Date: 18 July 1960
Wind: 6 Knots
Relative Humidity: 65%
Barometer: 30.04

TABLE 33

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

2. DURING HOVERING IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(G) WHAT IS HOTTEST CYLINDER HEAD? 1 AND ON WHICH ENGINE? ______

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ______

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? ______

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN GROUND OPERATION OR HOVERING, START TEST AT TAKE-OFF POWER, REDUCING TO MAXIMUM CONTINUOUS POWER FOLLOWING DURATION OF TAKE-OFF POWER TIME LIMIT UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED.

(1) IS TEST CONDUCTED HOVERING TAIL INTO THE WIND?
(WIND VELOCITY NOT TO EXCEED 10-12 MPH).........ZERO WIND (YES) NO
A. IF "NO", IS ANOTHER CONDITION DEEMED CRITICAL? ........... YES NO
B. WHAT IS THIS CONDITION?
1. CROSSWIND ______
2. NOSE INTO WIND ______

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 1 ) | CYLINDER BASE (No. ____ ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 424 | | 214 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 424 | | 214 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 50 | | 50 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 91 | | 90 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 91 | | 90 |
| (6) | .0036 X (3) | | .18 | | .18 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.82 | | 99.82 |
| (8) | $\triangle$ T = (7) − (5) | °F | 9 | | 10 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 9 | X | 10 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 433 | | 224 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 97 | | 6 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................ (YES) NO

TABLE 34

SECTION III, POWER PLANT OPERATION

Original Mixing Box Installation

C. COOLING (CONTINUED)

3. DURING LEVEL FLIGHT AT M.C. POWER IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REF. PAGE NO.~~ ---- ; ~~WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
.............................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ____________

(G) WHAT IS HOTTEST CYLINDER HEAD? 5 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | LEVEL FLIGHT SPEED M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | HEAD* | BARREL | OIL | M.P. "HG | R.P.M. | C.A.T.°F | I.A.S. | C.A.S. |
| 0 | 500 | 77 | 431 | | 212 | 27 | 3100 | 94 | 35 | 35 |
| 1 | | 78 | 438 | | 210 | | | 86 | 61 | 57.5 |
| 2 | | 80 | 444 | | 208 | | | 82 | 77 | 75 |
| 4 | | 80 | 444 | | 203 | | | 83 | 79 | 76 |
| 5 | | 79 | 443 | | 199 | | | 82 | 79 | 75 |
| 7 | | 79 | 444 | | 198 | | | 82 | 79 | 75 |
| 9 | | 78 | 430 | | 198 | | | 81 | 81 | 77 |
| 10 | | 79 | 445 | | 196 | | | 81 | 78 | 75 |
| 11 | | 80 | 446 | | 194 | | | 82 | 78 | 75 |
| 13 | | 79 | 448 | | 194 | | | 81 | 85 | 80.5 |
| 14 | 500 | 78 | 446 | | 194 | 27 | 3100 | 81 | 78 | 75 |
| | | | | | | | | | | |

* Washer Type Thermocouple

Test Date: 6 July 1960
Relative Humidity: 60%
Barometer: 30.18

TABLE 35

SECTION III, POWER PLANT OPERATION

C. Cooling (Continued)

3. During Level Flight At M.C. Power In Air Free Of Visible Moisture (Continued)

(J) After Engine Temperatures Have Stabilized In Flight At Cruising, Start Test At Maximum Continuous Power At The Lowest Practicable Altitude And Continue Level Flight At This Power Setting Until At Least 5 Minutes After The Occurrence Of The Highest Temperature Recorded:

(K) Temperature Values And Correction:

| Line No. | Item | | Cylinder Head (No. 5) | Cylinder Base (No. ) | Oil Inlet |
|---|---|---|---|---|---|
| (1) | Maximum Observed Temperature | °F | 448 | | 210 |
| (2) | True Observed Temperature | °F | 448 | | 210 |
| (3) | Pressure Altitude At Which Temp. Stabilizes Or Final Peak Occurs | Ft. | 500 | | 500 |
| (4) | Observed O.A.T. Air Temperature At (3) | °F | 79 | | 78 |
| (5) | True O.A.T. Air Temperature At (3) | °F | 79 | | 78 |
| (6) | .0036 x (3) | | .28 | | .28 |
| (7) | Standard Hot Day Temperature At (3) = 100 - (6) | °F | 99.72 | | 99.72 |
| (8) | Δ T = (7) – (5) | °F | 21 | | 22 |
| (9A) | Temperature Correction Increment (Head & Oil) = 1.0 x (8) | °F | 21 | X | 22 |
| (9B) | Temperature Correction Increment (Base) = .7 x (8) | °F | X | | X |
| (10) | Corrected Temperature = (2) + (9) | °F | 469 | | 232 |
| (11) | Maximum Permissible Temperature | °F | 530 | | 230 |
| (12) | Cooling Margin = (11) – (10) | °F | 61 | | -2 |
| (13) | Is Cooling Satisfactory? | | Yes | Yes | Yes |

(6.100(a)) (L) Are All Calibration Curves Attached? ...........(Yes) No

TABLE 36

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Clean Cartridge

C. COOLING (CONTINUED)

3. DURING LEVEL FLIGHT AT M.C. POWER IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REF: PAGE NO.~~ - - - - ; ~~WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(e)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
............................................(NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ________

(G) WHAT IS HOTTEST CYLINDER HEAD? 5 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | LEVEL FLIGHT SPEED M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | * HEAD | BARREL | OIL | M.P. "HG | R.P.M. | C.A.T.°F | I.A.S. | C.A.S. |
| 0 | 500 | 78 | 420 | | 190 | 27 | 3100 | 80 | 69 | 67 |
| 1 | | 79 | 430 | | 194 | | | 81 | 75 | 74 |
| 2 | | 79 | 432 | | 192 | | | 80 | 77 | 75 |
| 3 | | 73 | 439 | | 194 | | | 82 | 75 | 74 |
| 4 | | 79 | 442 | | 194 | | | 82 | 75 | 74 |
| 5 | | 78 | 440 | | 196 | | | 82 | 71 | 69 |
| 7 | | 77 | 416 | | 194 | | | 82 | 75 | 74 |
| 8 | | 79 | 430 | | 196 | | | 81 | 69 | 67 |
| 9 | | 79 | 428 | | 194 | | | 81 | 75 | 74 |
| 10 | | 78 | 431 | | 194 | | | 82 | 75 | 74 |
| 11 | 500 | 79 | 432 | | 194 | 27 | 3100 | 81 | 75 | 74 |
| | | | | | | | | | | |

*Washer Type
Thermocouple

Test Date: 16 July 1960
Relative Humidity: 60%
Barometer: 30.11

TABLE 37

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

3. DURING LEVEL FLIGHT AT M.C. POWER IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT AT CRUISING, START TEST AT MAXIMUM CONTINUOUS POWER AT THE LOWEST PRACTICABLE ALTITUDE AND CONTINUE LEVEL FLIGHT AT THIS POWER SETTING UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED:

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 5 ) | CYLINDER BASE (No. ) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 442 | | 196 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 442 | | 196 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 500 | | 500 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 79 | | 82 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 79 | | 82 |
| (6) | .0036 X (3) | | .284 | | .285 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.72 | | 99.72 |
| (8) | $\Delta T = (7) - (5)$ | °F | 21 | | 18 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 21 | | 18 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | | | |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 463 | | 214 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 67 | | 16 |
| (13) | IS COOLING SATISFACTORY? | | Yes No | Yes No | Yes No |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? ................................(Yes) No

TABLE 38

SECTION III, POWER PLANT OPERATION

H-23C Filter Installation
Restricted to 10" $H_2O$

C. COOLING (CONTINUED)

3. DURING LEVEL FLIGHT AT M.C. POWER IN AIR FREE OF VISIBLE MOISTURE:

(A) TAKE-OFF WEIGHT (MAX.) 2500 LBS.; C.G. 81.0 INS. FROM DATUM;
~~REF. PAGE NO.~~ ----- ; ~~WT. AND BALANCE REPORT NO.~~ Ref: AN-01-1B-40

(B) FUEL OCTANE NO. 100/130 (MINIMUM APPROVED FOR ENGINE)

(C) MIXTURE SETTING Full Rich

(D) THROTTLE SETTING Full Open

(E) SHUTTER POSITION N/A

(6.613(E)) (1) FOR ROTORCRAFT EQUIPPED WITH COOLING SHUTTERS, IS A CYLINDER HEAD TEMPERATURE INDICATOR PROVIDED FOR EACH ENGINE? ....... YES NO

(F) IN MULTI-ENGINE ROTORCRAFT, IS ONE ENGINE INOPERATIVE?
........................................... (NOT APPLICABLE) YES NO
WHICH ENGINE IS INOPERATIVE? ________

(G) WHAT IS HOTTEST CYLINDER HEAD? #5 AND ON WHICH ENGINE? ________

(H) WHAT IS HOTTEST CYLINDER BARREL? N/A AND ON WHICH ENGINE? ________

(I) WHICH ENGINE HAS HIGHEST OIL INLET TEMPERATURE? N/A

| TIME (MINUTES) | PRESSURE ALTITUDE (FT.) | OBSERVED TEMPERATURES °F | | | | OPERATING ENGINE(S) | | | LEVEL FLIGHT SPEED M.P.H. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | O.A.T. | * HEAD | BARREL | OIL | M.P. "HG | R.P.M. | C.A.T. °F | I.A.S. | C.A.S. |
| 0 | 500 | 80 | 405 | | 176 | 27 | 3100 | 80 | 71 | 69 |
| 1 | | 80 | 415 | | 178 | | | 81 | 69 | 67 |
| 2 | | 78 | 404 | | 180 | | | 80 | 72 | 70 |
| 4 | | 78 | 405 | | 181 | | | 79 | 68 | 66 |
| 5 | | 78 | 415 | | 180 | | | 80 | 75 | 73 |
| 7 | | 78 | 425 | | 185 | | | 79 | 74 | 71 |
| 6 | | 79 | 416 | | 185 | | | 81 | 70 | 68 |
| 10 | | 77 | 419 | | 185 | | | 81 | 72 | 70 |
| 11 | | 78 | 405 | | 184 | | | 79 | 69 | 67 |
| 12 | | 78 | 418 | | 185 | | | 80 | 72 | 70 |
| 14 | | 77 | 418 | | 182 | | | 81 | 74 | 71 |
| 15 | 500 | 78 | 420 | | 185 | | | 79 | 74 | 71 |

*Washer Type Thermocouple

Test Date: 18 July 1960
Relative Humidity: 65%
Barometer: 30.04

TABLE 39

SECTION III, POWER PLANT OPERATION

C. COOLING (CONTINUED)

3. DURING LEVEL FLIGHT AT M.C. POWER IN AIR FREE OF VISIBLE MOISTURE (CONTINUED)

(J) AFTER ENGINE TEMPERATURES HAVE STABILIZED IN FLIGHT AT CRUISING, START TEST AT MAXIMUM CONTINUOUS POWER AT THE LOWEST PRACTICABLE ALTITUDE AND CONTINUE LEVEL FLIGHT AT THIS POWER SETTING UNTIL AT LEAST 5 MINUTES AFTER THE OCCURRENCE OF THE HIGHEST TEMPERATURE RECORDED:

(K) TEMPERATURE VALUES AND CORRECTION:

| LINE No. | ITEM | | CYLINDER HEAD (No. 5 ) | CYLINDER BASE (No.______) | OIL INLET |
|---|---|---|---|---|---|
| (1) | MAXIMUM OBSERVED TEMPERATURE | °F | 425 | | 185 |
| (2) | TRUE OBSERVED TEMPERATURE | °F | 425 | | 185 |
| (3) | PRESSURE ALTITUDE AT WHICH TEMP. STABILIZES OR FINAL PEAK OCCURS | FT. | 500 | | 500 |
| (4) | OBSERVED O.A.T. AIR TEMPERATURE AT (3) | °F | 78 | | 78 |
| (5) | TRUE O.A.T. AIR TEMPERATURE AT (3) | °F | 78 | | 78 |
| (6) | .0036 X (3) | | .28 | | .28 |
| (7) | STANDARD HOT DAY TEMPERATURE AT (3) = 100 − (6) | °F | 99.72 | | 99.72 |
| (8) | $\Delta$T = (7) − (5) | °F | 22 | | 22 |
| (9A) | TEMPERATURE CORRECTION INCREMENT (HEAD & OIL) = 1.0 X (8) | °F | 22 | X | 22 |
| (9B) | TEMPERATURE CORRECTION INCREMENT (BASE) = .7 X (8) | °F | X | | X |
| (10) | CORRECTED TEMPERATURE = (2) + (9) | °F | 447 | | 208 |
| (11) | MAXIMUM PERMISSIBLE TEMPERATURE | °F | 530 | | 230 |
| (12) | COOLING MARGIN = (11) − (10) | °F | 83 | | 22 |
| (13) | IS COOLING SATISFACTORY? | | YES | YES | YES |

(6.100(e)) (L) ARE ALL CALIBRATION CURVES ATTACHED? .................................. (YES) No

TABLE 40
ICING TEST - FILTER MEDIA

Media Description: 1" Paper Pleat / 3/4" Batt Media
1/2 Standard Size Cartridge

Contaminant: Coarse A.C. Dust

Dust Add Rate: 9 grams per minute

Turn Table Setting: 29

Test No.: A.T.C. 3

Date: 21 Jan. 1959

Operator:

Barometric Press: 29.72 "Hg

Air Temp: 78 Deg. F.

Relative Humidity - 21%

| Run Time Min. | Air Flow CFM | Orifice $\Delta P$ "$H_2O$ | Orifice Static Pressure | Media $\Delta P$ "$H_2O$ | Cover $\Delta P$ "$H_2O$ | Remarks |
|---|---|---|---|---|---|---|
| | 50 | 0.25 | 1.80 | 0.50 | 0.39 | |
| | 100 | 0.90 | 2.45 | 1.25 | 0.90 | |
| | 150 | 2.05 | 4.60 | 2.40 | 1.62 | |
| | | Ice Formed on Cartridge | | | | |
| 0 | 150 | 2.05 | 4.25 | 2.10 | 1.30 | |
| 3 | " | " | 4.45 | 2.30 | 1.60 | |
| 5 | " | " | 4.90 | 2.75 | 2.02 | |
| | | Ice Formed on Cartridge | | | | |
| 8 | 150 | 2.05 | 5.45 | 3.80 | 2.60 | |
| 10 | " | " | 6.10 | 4.90 | 3.20 | |
| | | Ice Formed on Cartridge | | | | |
| 13 | 150 | 2.05 | 7.15 | 4.80 | 4.15 | |
| 15 | " | " | 8.00 | 5.80 | 5.15 | |
| | | Ice Formed on Cartridge | | | | |
| 18 | 150 | 2.05 | 9.45 | 7.15 | 6.50 | |
| 20 | " | " | 10.95 | 8.65 | 8.00 | |
| | | Ice Formed on Cartridge | | | | |
| 23 | 150 | 2.05 | 12.80 | 10.50 | 9.80 | |
| 23-18 | " | " | 13.05 | 10.70 | 10.00 | |
| 0 | " | " | | | 9.25 | |
| 1.00 | " | " | | | 10.00 | Cartridge Pressure Drop after Thawing |

TABLE 41
ICING TEST - FILTER MEDIA

Media Description: 1" Paper Pleat / 3/4" Batt Media
1/2 Standard Size Cartridge

Contaminant: Coarse A.C. Dust

Dust Add Rate: 9 grams per minute

Turn Table Setting: 29

Test No.: A.T.C. 5

Date: 26 Jan. 1959

Operator:

Barometric Press: 30.23 "Hg

Air Temp: 75° Deg. F.

| Run Time Min. | Air Flow CFM | Orifice $\Delta P$ "$H_2O$ | Orifice Static Pressure | Media $\Delta P$ "$H_2O$ | Cover $\Delta P$ "$H_2O$ | Remarks |
|---|---|---|---|---|---|---|
| 0 | 150 | D.R. | | 2.00 | 1.20 | |
| 3 | " | | | 2.05 | 1.25 | |
| 5 | " | | | 2.20 | 1.35 | |
| | | Ice Formed on Cartridge | | | | |
| 8 | 150 | | 5.20 | 2.70 | 1.95 | |
| 10 | " | | 5.30 | 2.90 | 2.20 | |
| | | Ice Formed on Cartridge | | | | |
| 13 | 150 | | 6.40 | 3.95 | 3.25 | |
| 15 | " | | 7.00 | 4.60 | 3.95 | |
| | | Ice Formed on Cartridge | | | | |
| 18 | 150 | | 7.80 | 5.40 | 4.70 | |
| 20 | " | | 8.80 | 6.25 | 5.60 | |
| | | Ice Formed on Cartridge | | | | |
| 23 | 150 | | 10.00 | 7.50 | 6.80 | |
| 25 | " | | 12.00 | 9.45 | 8.60 | |
| | | Ice Formed on Cartridge | | | | |
| 26 | 150 | | 13.70 | 11.10 | 10.00 | |

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